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Information Technology

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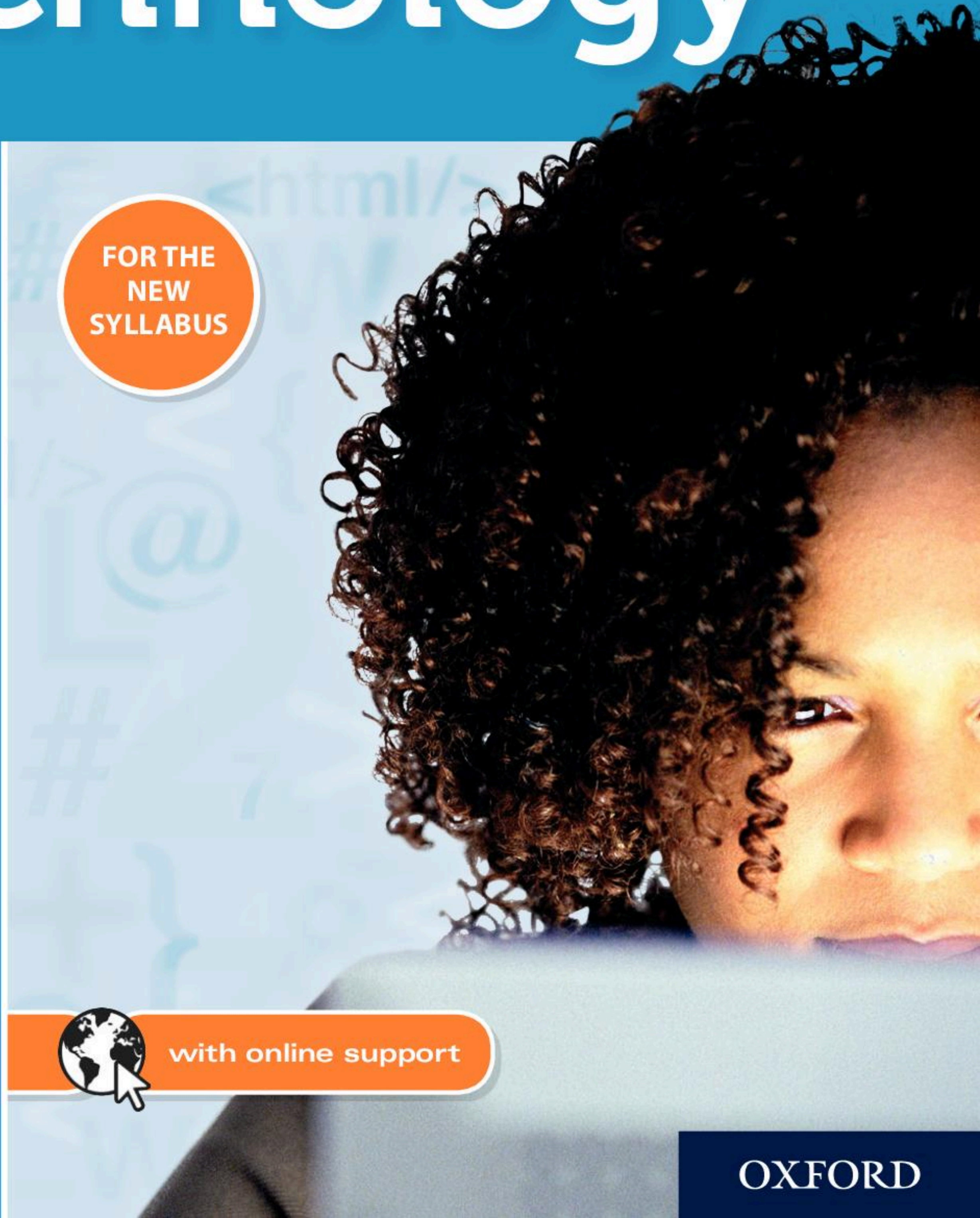

FOR THE NEW SYLLABUS

with online support

Glenda Gay
Ronald Blades

OXFORD

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Great Clarendon Street, Oxford, OX2 6DP, United Kingdom

Oxford University Press is a department of the University of Oxford.

It furthers the University's objective of excellence in research, scholarship, and education by publishing worldwide. Oxford is a registered trade mark of Oxford University Press in the UK and in certain other countries

First published in 2019

British Library Cataloguing in Publication Data

Data available

978-0-19-843716-1

1 3 5 7 9 10 8 6 4 2

Paper used in the production of this book is a natural, recyclable product made from wood grown in sustainable forests.

The manufacturing process conforms to the environmental regulations of the country of origin.

Printed in India by Manipal Technologies Ltd

Acknowledgements

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Preface

In this, the third edition of Oxford Information Technology for CSEC, we are providing new material that incorporates the recent changes to the Caribbean Examination Council's Information Technology (IT) syllabus. Almost 20 years into the new millennium, it is clear how information and communications technology is an invaluable resource in every sector, including education. This textbook aims to support the interest of the Caribbean student in the use of ICT tools for productivity and problem solving. It will provide you with the support material to fully explore every section of the IT syllabus. The resources in the textbook are presented through topic discussion, worked examples and a wide range of questions. Our years of interacting with students and educators from across the region have helped us to design this resource material to be used effectively.

For the most part, the chapters have been aligned with the sections of the syllabus. However, we have maintained the separation of Chapter 1 (Fundamentals of hardware and software) and Chapter 2 (Information processing) to provide detailed treatment of these sections for the coverage of syllabus Section 1 (Computer Fundamentals and Information Processing).

Among the practical chapters is the updated Chapter 6 (Web page design), which provides material needed for the theory examination and the practical requirement for the School Based Assessment (SBA). Chapter 9 (Problem solving) and Chapter 10 (Program implementation) have continued to prove challenging to Caribbean candidates. Teachers can now choose which programming language their students can use, while the textbook continues to offer support in these areas of programming, with several examples and questions.

Chapter 11 introduces Pascal programming fundamentals for those comfortable with this method of writing code, while Chapter 12 introduces Visual Basic for Applications, which can support the Microsoft applications used for word processing, spreadsheets and database management.

Each chapter is subdivided into sections based on the specific objectives from the syllabus. End-of-section questions provide reinforcement on the topics covered in a section. There are more questions at the end of each chapter which take a different approach; testing learning from other chapters. The intention is to familiarise students and teachers with this approach to questioning for the new exam format, using real-world examples. The appendix includes useful hints for guidance through the SBA, whether candidates are working as individuals or as a part of a group.

It is our intention through this text to once again provide a supportive resource for each candidate to achieve success in their IT examination, as each candidate prepares to embrace new technologies which will inevitably arrive in years to come.

CSEC IT Structure	Syllabus Section
Paper 1: 1 ¼ hours: 60 compulsory multiple-choice questions. *30% of final mark*	*35 questions – Theory* *15 questions – Productivity tools* *10 questions – Problem solving*
Paper 2: 2 hours: Four compulsory questions from all areas of the syllabus. *45% of final mark*	*35 marks – Theory* *30 marks – Productivity tools* *25 marks – Problem solving and programming*
Paper 3-1: School Based Assessment (SBA). One practical assignment comprising word processing, web page design, spreadsheets, database management, problem solving and programming. *25% of final mark*	*Productivity tools* *Problem solving and programming*
Paper 3-2: Alternative to the School Based Assessment for private candidates. A theory and practical paper testing the skills required for the School Based Assessment. *25% of final mark*	*Productivity tools* *Problem solving and programming*

Contents

What's on the website?

- Answers to all End of Chapter Exam-style Questions in this book.
- Additional Exam-style Questions for each chapter with sample answers and examiner analysis.
- Interactive Paper 1 multiple choice test, Practice Paper 2, worked SBA Paper 3 with advice on online marking, SBA alternative Paper 3
- Answers to all Workbook questions
- Comprehensive glossary of terms used in this book.

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CHAPTER 1

FUNDAMENTALS OF HARDWARE AND SOFTWARE

1.1 Basic computer components

Computers are an important aspect of information technology. A computer is an electronic device, operating under the control of instructions stored in its memory. Whether on its own or connected via a **network** (such as the Internet), it can:

- accept data (input)
- manipulate data (processing)
- produce results (output) from the processing
- store the data and results for future use (storage).

These four basic tasks of any computer represent the IPOS cycle (Fig 1.1).

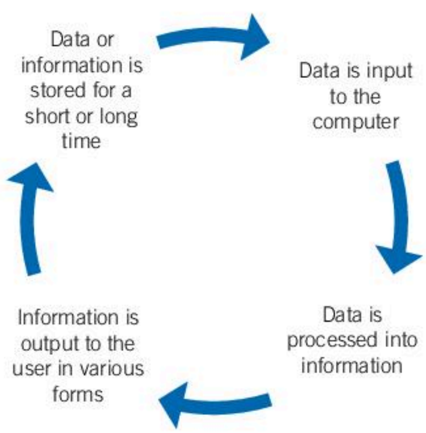


Fig 1.1 Four basic tasks of the IPOS Cycle

Components of a computer

The term 'computer' generally refers to desktop machines and laptops but it can also include handheld games consoles as well as portable devices, such as smartphones and tablets.

The basic components of a computer are categorised as either **hardware** or **software**.

Hardware

This is the name given to the physical parts of a computer (Fig 1.2). There are five general categories:

1 **The central processing unit (CPU)** is the brain of a computer and controls how the rest of the computer works. It includes the control unit (CU) and the arithmetic and logic unit (ALU). The CU carries out instructions in the software and directs the flow of data through the computer. The ALU performs the calculations and logic operations.
2 **Input devices** get data into a computer. A mouse, a keyboard and a scanner are all input devices.
3 **Output devices** get processed information out of a computer, for example to a printer, computer screen or even to speakers.
4 **Memory** enables a computer to temporarily store instructions and data.
5 **Storage media** include hard disks, CD-ROMs, DVDs, and USB flash memory sticks, while the **storage devices** include hard disk **drives**, CD-ROM drives and DVD drives. Most of these devices can read data whilst others, such as USB flash memory sticks, allow data to be saved as well as read.

Peripheral devices are located outside the CPU but are controlled by it. That is, they can be added to a computer system. Input, output and storage devices may be peripheral devices.

Software

This is the name given to computer programs that tell the hardware how to work. Without software the computer hardware would do absolutely nothing, as

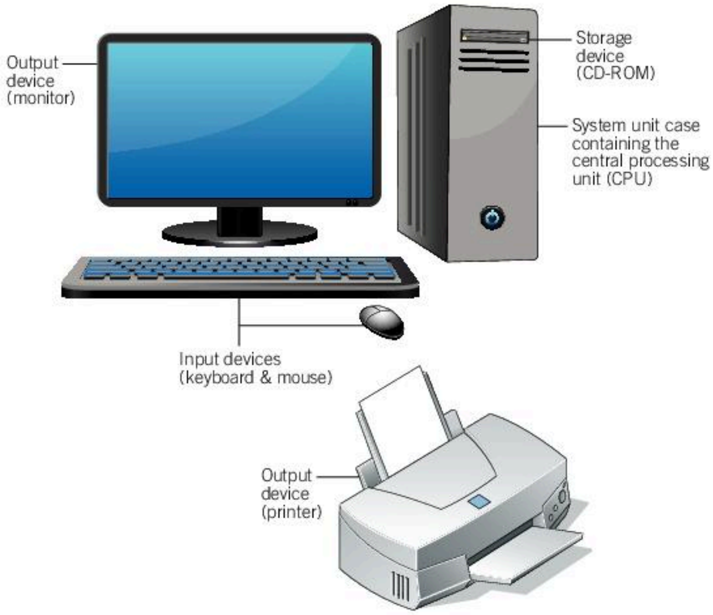


Fig 1.2 The basic categories of computer hardware

there would be no instructions. Software includes the following types of program.

Computer programs

These are instructions (programs) produced by programmers to create system and application software.

System software

This software is usually called an **operating system** since it controls the hardware and how all other software works. The most commonly used operating system is Windows, written by the Microsoft Corporation.

System software also includes **utility software**. This software aims to protect and maintain the system software, just as a mechanic maintains the smooth working of a car's engine when it is serviced. Examples of the tasks undertaken by utility software include: protecting software against damage caused by computer viruses, making copies of **files** ('backing up'), and recovering files after software has stopped working ('crashed').

Application software

Application software is software that instructs a computer to carry out a specific task. Word processors, spreadsheets and databases are all application software.

Information and communication technology

Now that we have discussed how data can be input, processed, stored and output to produce information, we introduce two important terms:

Information Technology (IT) is the term used to describe the equipment (hardware and computer programs or software) that allows us to access, retrieve convert, store, organise, manipulate and present data and information. IT may also refer to the use of such equipment and programs to produce the information.

Communications Technology (CT) is the term used to describe telecommunications equipment through which data and information can be accessed. Examples of CT equipment are phones, faxes, scanners, modems and computers.

Questions

1 List the four basic tasks of any computer.

2 State the name of the cycle that represents the four basic tasks listed in question 1.

3 What is the general name given to the physical parts of a computer?

4 Explain what each of the following terms represent:
- **a** CPU
- **b** CU
- **c** ALU.

5 Explain the difference between an input device and an output device.

6 What is another name for system software?

7 What is the general name given to each of the following descriptions:
- **a** computer programs that tell the hardware how to work
- **b** telecommunications equipment through which data and information can be accessed.

Data must be provided in a suitable form for any computer system to be able to process it. So, it is always important to think of the different ways of entering data into a computer, particularly since all data needs to be entered as accurately as possible. 'Input' means to enter data, programs, commands and user responses into the memory of a computer. Therefore, an input device is any device that transfers data from the outside world into a computer.

Although most input devices can be connected to desktop computers, you probably come across others and do not realise it! For example, every time you use a remote control for a television or a games console, data is entered using a special keyboard.

There are many different input devices and media, each one being suitable for a different purpose. The two general categories of input devices are manual input devices and direct data entry (DDE) devices.

Manual input devices

With a manual input device, you must enter or transfer data into the computer yourself. Some examples of these devices are explained next.

Keyboard and keypad

A keyboard has a set of alphabet keys, a set of digit keys and various function keys, so the data entered by the person operating the keyboard is in the form of individual letters, words or numbers. When you press a key on the keyboard, a number (code) is sent to the computer to tell it which key you have pressed. The keyboard has the disadvantage that it is easy to make mistakes by pressing the wrong keys.

Other special keyboards designed to do just one job can be found on children's toys, games consoles and programmable robots used in primary schools. The 'keyboard' could be a picture of a farmyard. Pressing on an animal would cause the computer to make the noise of the animal. A keypad is a block of buttons that contain digits, symbols or alphabetical letters. Keypads can also be found on many keyboards.

Mouse

You can also move data directly into a computer using a range of input devices. The most common is a pointing input device called a **mouse**. As you move it along a flat surface, the pointer on the screen moves in the same direction. If the mouse has two buttons, the left one is

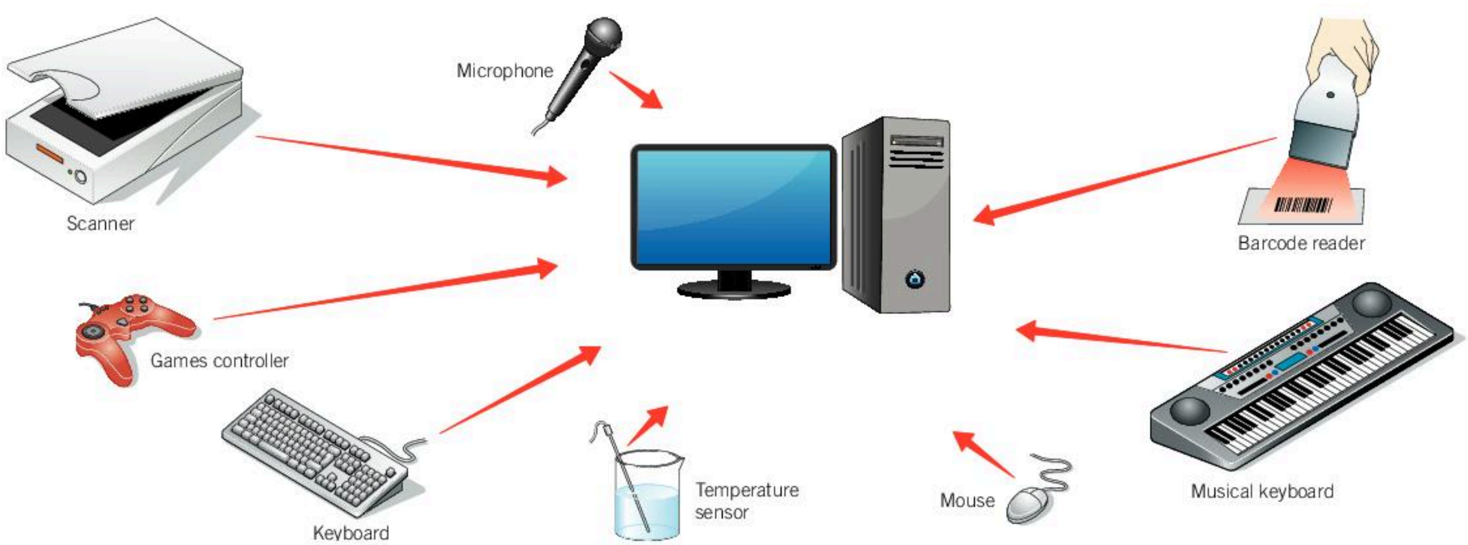


Fig 1.3 Input devices: getting data into the computer

used to 'select' items such as text and the right one is used to 'access' menus. The mechanical mouse has a rubber ball underneath to help it roll smoothly in all directions. The optical mouse uses light to track its movements. The cordless mouse is not physically connected to the computer, but instead uses infrared or radio waves to communicate with the computer.

Document scanner

A scanner allows you to transfer pictures, graphics and text to your computer. It scans the image from the top to the bottom one line at a time and transfers it to the computer. You can then take that copy and use it in a program, send it as an email attachment or print it.

Microphone

Data can be entered into a computer through a microphone. The computer responds to this data by carrying out instructions such as printing a document or turning the spoken words into text in a word processor. These are called voice-activated or voice-response systems.

Digitiser

Digitisers convert drawings and images into data. For example, a digital camera captures still and video images and stores them in electronic format for printing or editing later. A **webcam** is a type of digital camera connected to a computer, typically for transmission of still or moving images over the Internet or other network. Some computer users use webcams to see each other while chatting online, or for streaming live video. Other uses of webcams include monitoring traffic on highways and other surveillance.

Another type of digitiser is found in a graphics tablet, that can capture drawings and handwritten signatures. It is a flat, touch-sensitive drawing surface that uses a special pen called a stylus. Images from the graphics tablet are also shown on a monitor. When a transparent digitiser element of this kind overlays a screen it allows direct interaction with the screen.

Touch-sensitive devices

A **touchscreen** is another way to input data (Fig 1.4). It is a screen that is sensitive to touch, so you do not need to use a keyboard or mouse. Banks, malls and restaurants use touchscreen kiosks or touch terminals to provide information to the public. Touchscreens are also commonplace on handheld devices such as mobile phones and iPads.

Fig 1.4 Touchscreens, such as the one shown here, are popular in public places as there is no need to use a mouse or a keyboard

A **touchpad** is a flat rectangular surface which also senses the movement of one or more fingers on its surface. These devices are usually found on laptop and notebook computers and function as a mouse does to move a pointer.

Pointing devices

A light pen is similar to a mouse, but is rarely used since touch-sensitive devices have replaced it. A variation of the light pen is a **stylus,** which is a small pen-like device with a plastic or felt tip that uses pressure instead of ink. A stylus is used to draw on graphics tablets or type on touchscreens to avoid using fingers on the screen.

Remote-control devices

These devices send data through signals each time a button is pressed on the device. The signal is received by another device that processes the instruction.

Remote control devices are used to change television and radio station channels, open electronic gates and manage slide presentations.

Biometric systems

These systems use some part of a person's body to uniquely identify them. There are two types of biometric systems that can identify someone. One is related to some aspect of the body using, for example, fingerprints, face or iris recognition (Fig 1.5), as well as the size and shape of the hand. These characteristics are consistent and rarely change. In contrast, a person's signature and tone or pitch of voice are related to the person's behaviour. For example, if you are nervous, then your signature or voice may change.

Fig 1.5 An electronic signature can uniquely identify a person

Direct data entry (DDE) devices

A direct data entry device can transfer information automatically from a document – such as a form or barcode – into the computer. You do not need to enter the information manually.

These devices are used when large volumes of data must be entered into the computer quickly. Previously, it took a relatively long time for a supermarket cashier to add up the cost of your grocery items using a cash register. Nowadays barcode systems make this task much quicker. There are various DDE devices available. As with manual input devices, different DDEs are suitable for different purposes. Some examples are explained below.

Barcode reader

A **barcode** is a group of vertical bars of different widths. Barcodes are found on almost all the products we buy. Groups of bars are used to represent different numbers which are often printed above or below the barcode. The numbers normally included in a barcode for a product represent its country of origin, manufacturer and item code. The price is not included in the barcode.

Barcodes are read into the computer using a wand or a fixed scanner. There are also camera-based barcode readers. Barcodes are not easily damaged and can normally still be read if they are creased or slightly wrinkled. They can be printed using a normal printer and ink, and so are cheap to produce.

Fig 1.6 A barcode is found on many products

A barcode is used to enter data directly into a system. The data collected from barcodes is used to produce customers' bills and to tell a store what has been sold. Goods can then automatically be re-ordered. These systems, known as electronic point of sale (EPOS) systems, enable large amounts of data to be input very quickly and accurately.

Smart card

Millions of people now pay for their shopping using credit, debit or store cards. The magnetic strip on the back of such a card is 'read' as it is being 'swiped' by a salesperson. This swiping transfers account information and the cost of the goods, into the banking system. This type of system is referred to as electronic funds transfer at point of sale (EFTPOS).

To gather information from the card, it is swiped through a machine which quickly and accurately reads the magnetic pattern. If the magnetic area on the card is scratched or gets soiled, then the information stored on the card can be corrupted. Such a card is used by businesses to reward loyal customers.

A card that does not rely on a magnetic strip is also now appearing. It has a built-in electronic circuit and a set of gold-coloured contacts. Putting the card in a special reader inputs the information held in the circuit. Such cards are called **smart cards**. They are more sophisticated than magnetic swipe cards.

Although smart cards are often called input devices, they are actually simple storage devices. When the card is put into a machine, data can be read from the card or written onto it. A smart card can store much more data than a magnetic strip.

Smart cards, unlike magnetic-strip-based cards, can carry all necessary functions and information on the card. Therefore, they do not require access to remote databases at the time of the transaction.

Fig 1.7 Smart cards have a built-in electronic circuit and a set of gold-coloured contacts

Optical mark recognition (OMR)

There are various ways of inputting letters, words and numbers automatically into a system. For example, when you buy a lottery ticket, you fill in the slip by putting lines through sets of numbers on a grid (Fig 1.8). This slip is then fed into a machine that reads the marks.

The computer system turns each set of marks into numbers and enters them into the draw. This method of entering data is called optical mark recognition (OMR) and relies on precisely positioned marks on a form being read by a special scanner. This data is then processed by the system.

If you have multiple-choice tests as part of your examinations, you will probably have to answer them on an OMR form. These answer sheets will be passed through a scanning system to mark your answers. This way of inputting data is fast and accurate. OMR is therefore used to read the data that has been added and then all the data can be transmitted to the computer automatically. The final information can then be produced without any need for human intervention.

Fig 1.8 Data can be entered into a computer in different ways. Lottery slips are an example of optical mark recognition (OMR)

Optical character recognition (OCR)

Another way of entering handwritten or printed text into a computer system is to scan the text using an optical character recognition (OCR) program. The scanned text is turned into a file that can be edited, reformatted and reprinted by a word processor. The accuracy of OCR is variable and can be poor, particularly if the original pages to be scanned are of poor quality.

OMR and OCR are often used together in a **turnaround document**. A turnaround document is one which has some unique information printed on it by a computer with other information which needs to be added to it by a human. It is then fed back into a computer a second time to transfer the added information to the computer.

Magnetic ink character recognition (MICR)

Banks process millions of cheques each day. Every cheque has the cheque number, account number and branch code printed on it using magnetic ink (Fig 1.9). A magnetic ink character reader (MICR) reads this information along with the amount of the cheque into the banks' information systems, so that the cheques can be cashed.

MICR readers can only read one special font, which includes only numbers and a few punctuation marks. They can read characters very quickly and with 100% accuracy. Information printed in magnetic ink is also very secure since it is not possible to change the information by writing over it with a pen. The magnetically printed numbers are also not damaged by folding the cheque (as often happens). Both the reader used by MICR and the magnetic ink are expensive.

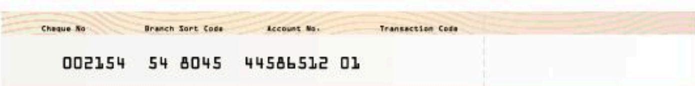


Fig 1.9 Magnetic ink symbols printed on the cheque

Sensors

The music industry uses musical instrument digital interface (MIDI) systems. Here, data is input through a piano-type keyboard or by sensors that respond to being struck. A wide variety of sounds can then be generated from one keyboard or set of pads.

Sensors are available which respond to a wide variety of signals. They can be used to collect data automatically into a system. For example, the Meteorological Office has weather forecasting systems that collect data from sensors around the world and in space. These sensors collect data on temperature, wind speed and direction, hours of sunshine and humidity. This data is processed to help meteorologists to predict the weather. As we know, the forecast is not always accurate, but large amounts of precise data are collected.

Information systems use sensors to input data so that the systems can decide what to do. When you approach an automatic door, a sensor tells the system you are there and makes the door open. Burglar alarms use sensors to inform the system when doors or windows have been opened or broken. This causes an alarm to sound or the police to be alerted automatically.

Table 1.1 *Input devices: advantages and disadvantages*

Input device	Application	Advantages	Disadvantages
Manual input devices			
Keyboard	(touch)		
Converts key strokes into binary digits. Carries out the commands of function keys such as 'End' and 'PgUp'	◆ Used to manually input text into the computer ◆ Used to type commands and instructions to computer systems	◆ Most common means of entering text ◆ Relatively inexpensive	◆ Continued use can cause repetitive strain injury ◆ Errors in transcription are common ◆ Speed of input depends on the user's experience
Mouse	(touch)		
Sends positional information to the computer, by clicking or scrolling of mouse buttons	◆ Acts as an interface between the user and the computer ◆ Used to issue commands directly to the computer	◆ Commands can be given directly to the computer (e.g. page down) ◆ Can activate commands by selecting icons directly	◆ Hand-to-eye coordination can be a problem ◆ Shifting between keyboard and mouse can be confusing

(continued)

Table 1.1 *Input devices: advantages and disadvantages (continued)*

Input device	Application	Advantages	Disadvantages
Joystick	(touch)		
Similar to a vehicle gear shift, but with buttons for different commands	◆ Generally used in game playing	◆ Ideal for games such as car racing and combat	◆ User has to become skilled at the sensitive movement of the joystick
Touchscreen	(touch)		
Allows the user to press parts of the screen to activate different functions	◆ Are located in public places such as restaurants and shopping malls where transactions can be made and information given	◆ Easy way to input options and choices ◆ Can be used by children and the physically challenged who are unable to use other input devices	◆ A limited number of values can be displayed on one screen at a time ◆ More expensive than a standard monitor
Scanner	(light)		
Used to capture an image in hard-copy and create a digital copy of the image	◆ Conversion of hard-copy images to soft-copy can be used to import and export documents and images across different applications	◆ Relatively cheap and easy to install ◆ Depending on use, flatbed or handheld scanners can be chosen	◆ The quality of the image depends on the quality of the hard-copy, scanner and scanner software
Graphics tablet	(machine-readable)		
Used to input lines and shapes through pressure and movement of a stylus on the tablet	◆ Captures input like hand-created drawings and signatures ◆ Resulting images can be displayed on a monitor	◆ Allows artists to sketch detailed digital drawings more easily than by using a mouse ◆ Can be used to capture signatures as a biometric	◆ Requires some practice ◆ More expensive than a mouse
Voice-recognition system	(sound)		
Data that is input in audio form. The input is analysed for commands which are then processed	◆ Allows users to dictate text or give commands directly to the computer	◆ The user can speak normally for dictation	◆ Must be trained to recognise voice patterns ◆ Software cannot interpret all English meanings
Direct data entry devices			
Barcode reader	(light *or* laser)		
Barcodes are groups of bars of different widths and are found on almost every product you buy. The codes are read into the computer using a wand or a fixed scanner	◆ Different groups of bars represent different numbers. These numbers represent the product's country of origin, manufacture and item code	◆ Data can be input much faster than it takes to be keyed in ◆ Not easily damaged ◆ Can be printed using a normal printer and ink and so cheap to produce	◆ The order of the data stored cannot be changed easily
Electronic Point of Sale (EPOS)	(laser)		
Data collected from the barcodes is used to produce information and update the database	◆ Used to record transactions and track inventory	◆ Prices of products can be easily updated ◆ Items can be easily scanned	◆ Depends on a reliable Internet connectivity
Optical Character Recognition (OCR)	(light)		
Text and graphics are scanned as soft copy	◆ Can be used to input large blocks of typed text	◆ Can speed up the typing process	◆ Accuracy of the text can be poor

(continued)

Table 1.1 *Input devices: advantages and disadvantages (continued)*

Input device	Application	Advantages	Disadvantages
Magnetic ink character recognition (MICR)	(magnetic)		
Data is printed as special characters using magnetic ink. This data is translated into text or values	◆ Used by banks to process cheques, by printing additional bank details (branch, account number)	◆ Is quick and highly efficient ◆ Both humans and machines can interpret the data ◆ Not easy to forge	◆ Has limited applications ◆ As the use of cheques becomes obsolete, its use is in decline
Optical Mark Recognition (OMR)	(light)		
Relies on the presence or absence of precisely positioned marks on a form being read by a special scanner. This data is then processed by the system	◆ Popular with lotteries and multiple-choice question sheets issued by examination boards	◆ Data input is very fast and accurate	◆ There is a limit to the number of responses ◆ Incorrect or inconsistent marking on the sheet may result in the data being rejected
Smart card	(magnetic)		
A magnetic strip containing encoded data about the owner of the card is placed on a plastic card	◆ Used to store data on debit, credit, loyalty, phone and other cards	◆ Can be used to store financial transactions ◆ Transactions are fast ◆ Saves the user from carrying cash	◆ Can be damaged ◆ May soon be replaced by embedded microchips
Musical Instrument Digital Interface (MIDI)	(sound)		
Can be used by musicians to create, manipulate and store sounds in a computer	◆ Used to store music from instruments or voice for editing	◆ Once stored, the data can be arranged in many ways	◆ Special software must be used to translate the music into a musical score

Questions

1 What is the general name for each of the following devices:

- **a** transfers data from the outside world into a computer
- **b** a flat rectangular surface which also senses movement of a finger on its surface
- **c** a system that uses some part of a person's body to uniquely identify them
- **d** transfers pictures, graphics and text to a computer
- **e** transfers information automatically from a document, such as a form or barcode into the computer
- **f** relies on precisely positioned marks on a form being read by a special scanner
- **g** a document which has some unique information printed on it by a computer, but other information needs to be added to it by a human before it is fed back into the computer.

2 What is the general name for each of the following processes:

- **a** data is entered or transferred into the computer by hand
- **b** to send data at a distance through signals each time a button is pressed on the device.

To get processed information out of a computer, you may need an output device. 'Output' means to show, print or store the results of processed data. The most common types of output are:

- Soft copy: this is not permanent. It includes output from a computer monitor, audio (sound) from speakers, electrical signals and output from one computer to another.
- Hard copy: this is also called permanent output since it is printed for you to review away from the computer. Examples are printed reports and pictures.

Display devices

Computers usually display output on a screen or monitor. Some monitors are separate and need to be plugged into the computer's system unit. Others, such as laptops and mobile devices, have their screens integrated to the system unit and keyboard. Televisions can also be used as computer monitors with some additional connections. Other display devices include interactive whiteboards (also called **smartboards**) used for teaching or presentations. These large touch-sensitive plastic boards respond to input either directly by connections to a computer or through other devices such as a projector, tablet or magnetic pen.

The most common types of display device include LCD (liquid crystal display) flatscreens and LED (light-emitting diode) screens on handheld devices and laptops.

A monitor contains a matrix or array of bright dots of red, green and blue (known as RGB). These can be blended to display millions of colours. Mapping the location and colour information of each bit of data creates a computer image. This is known as a bitmap (bmp). The bitmapped image seen on a monitor is made up of thousands of pixels. **Pixel** stands for picture (pix) element. Features of a computer screen include its size and resolution.

Fig 1.10 Various types of devices with displays

Features of a computer screen

Size

This is the dimension of the screen which shows the output. Common desktop screens are from 14 inches to 19 inches measured diagonally. Larger sizes are now available.

Resolution

This determines how clear and detailed the output on the screen can be. Pictures on a screen are made up of tiny dots (one dot = 1 pixel). The more pixels per inch, the clearer and more detailed the graphic.

Colour

The number of colours displayed can vary from 16 to 256 to 64 thousand to 16.7 million. The more colours, the smoother the graphics appear, especially photos.

Cursor/pointer

The cursor is a symbol that shows where you are working on the screen. It may appear as I for text and ➤ for the mouse pointer location.

Scrolling

This allows the text or graphic to be moved or up or down or brought into view on the screen.

Printing devices

No matter how simple or complex the data-processing operation is, the final result must be made available in a user-friendly form, and usually in the form of a permanent record. **Printers** are devices which output a hard copy of your work. The choice of printer depends on the speed, quality and quantity you want, and the cost. Some printers also perform the functions of a scanner, a photocopier and fax machine. Two main categories of printer are impact and non-impact.

Impact printers

Impact printers strike through a carbon or inked ribbon, like a typewriter. They are noisy and do not usually print acceptable graphics. However, they are useful for printing multiple copies using carbon paper, and printing payroll or financial reports that require continuous sheets of paper perforated to tear into individual sheets if necessary. Impact printers are largely obsolete now. However, there are still some dot-matrix printers in existence.

Dot-matrix printer

A dot-matrix printer uses pins to print a pattern of dots on paper. The main advantage of using dot-matrix printers is for printing multiple copies using carbon paper. The main disadvantage is the relatively poor quality of printing, which can be read but cannot be used for reproduction or for business letters.

Non-impact printers

These printers do not involve actually striking the paper. Instead, ink spray or toner powder is used. The characters are then fixed onto the paper by heating, for example. Because the printing element is simple and has no moving parts, these printers are inexpensive to manufacture and print quickly and quietly.

Inkjet printers

It is now possible to buy low-priced, good quality printers that can print in both black-and-white or colour. The quality of printout can be nearly as good as that of a laser printer, but inkjet printers are slower depending on what is to be printed. Speeds of 4 to 6 pages per minute may be achieved. Their cartridges need to be replaced more frequently than the toner cartridges of laser printers. Colour inkjet printers are ideal for use at home, where small-quantity output is required for greeting cards, photographs and school work. Ordinary paper can be used.

Laser printers

Laser printers produce attractive documents at a high resolution and are much faster than inkjets. They are used in many workplaces because they are quiet, print quickly, can be stocked with a large number of sheets of paper, and produce very high quality documents. The printout from most laser printers tends to be 300 to 1200 dots printed per inch (dpi). Many lines are printed simultaneously, and speeds of 8 to 12 pages per minute can be attained.

Colour laser printers are also available. They are far more costly to buy than colour inkjet printers, but produce higher quality images and are cheaper to run.

Thermal printers

Thermal printers use heat on chemically treated paper to form characters. Many automatic banking machine (ABM) receipts, debit or credit card slips and even some ultrasound scanned images are printed using thermal printers. These printers are quiet and more recent ones print quickly. However, the paper is expensive, and the print eventually fades if exposed to light or heat.

3D printers

Three-dimensional (3D) printers are similar to inkjet printers, but instead a 3D model is created layer by layer, from the bottom upward. The model is created over many hours, as each layer is printed on top of another. However instead of using ink as with the inkjet, the 3D printer uses melted plastic that sticks each layer to the previous one.

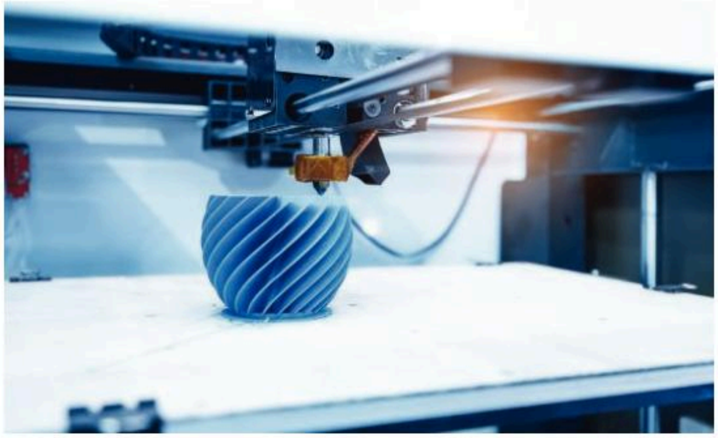


Fig 1.11 3D printers create a model layer by layer

Plotters

Car designers, architects and engineers who wish to print accurate charts, diagrams and 3D drawings, output not to a laser printer but to a plotter. A **plotter** uses coloured pens or toner to draw an image on paper (Fig 1.12). The paper is handled in different ways depending on the type of plotter. Flatbed plotters hold the paper still while the pens move. Drum plotters roll the paper over a cylinder, while pinch-roller plotters are a mixture of the two. The advantage of a drum plotter is that it can produce very large drawings.

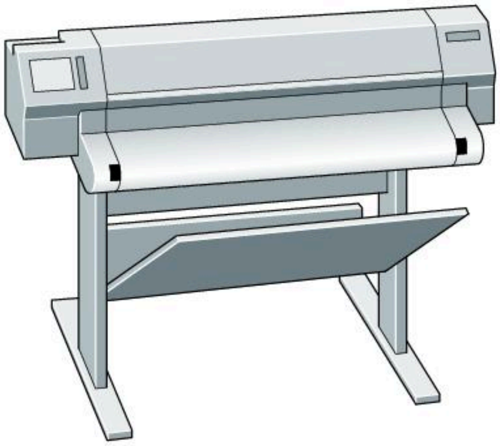


Fig 1.12 A plotter can produce very large drawings

Audio devices

Most computers sold to homes and schools include a sound card. This allows both the recording (input) and playback (output) of sound. Microphones record sound while loudspeakers can play sound to a group of people (Fig 1.13), however, headphones are more popular for users who wish to listen to the sound without disturbing anyone around them (Fig 1.14). These devices are small speakers that need to be placed close to one or both ears. Earphones or earbuds are very small headphones that fit inside the ear. A headset is a set of headphones, which has a microphone attached to allow you to speak and listen at the same time.

Fig 1.13 Microphones record sound while loudspeakers play back sound

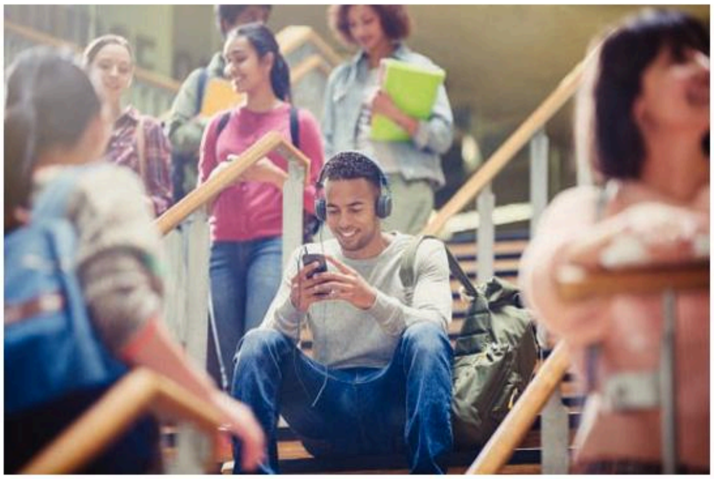


Fig 1.14 Headphones, headsets and earbuds are more popular for users who wish to listen to the sound without disturbing anyone

Sound may also be output from a digital file or as music from a CD. Some software applications will allow word-processed text to be read back to the user. This can be very important to young children or the visually impaired.

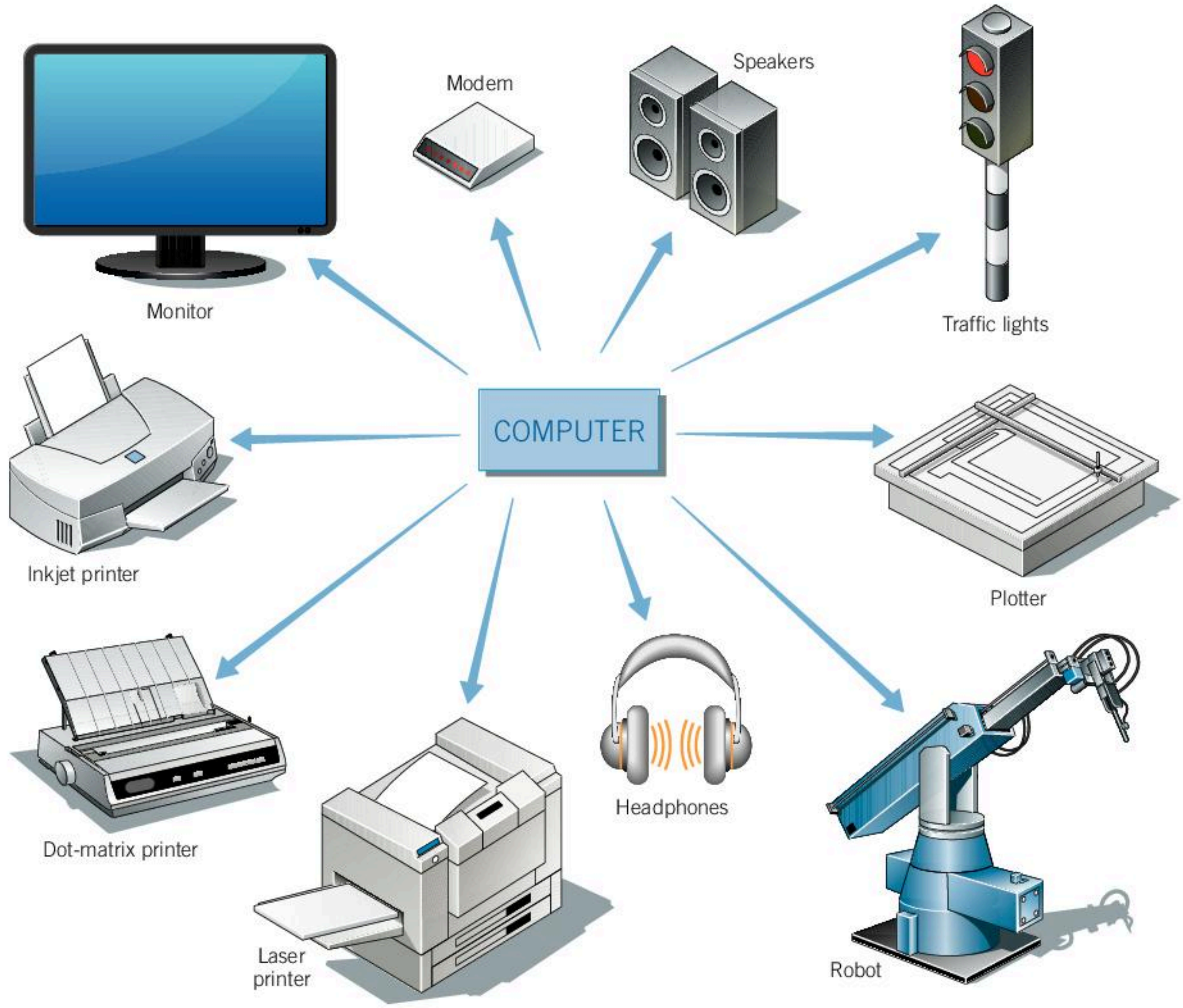


Fig 1.15 Output devices: getting data out of a computer

Questions

1 State three general types of output devices.

2 What is the general name for each of the following descriptions:

- **a** tiny dots that make up the pictures on a screen
- **b** devices which output a hard copy of your work
- **c** type of printer that is useful for printing multiple copies using carbon paper
- **d** type of printer that uses heat on chemically treated paper to form characters
- **e** a printer that uses melted plastic that sticks each printed layer to the previous one
- **f** very small audio output devices that fit inside the ears.

Some of the data you put into a computer will be needed right away for processing, while other data may not be needed for long periods of time. Therefore, different methods of storage are appropriate for different uses.

The main purpose of the CPU is to process instructions as quickly as possible. Main memory is located directly on the computer's main circuit board so that data can travel quickly to and from the CPU to be processed.

Main memory is located directly on the computer's main circuit board so that data can travel quickly to and from the CPU to be processed. Data stored at a specific memory location (called an address), can have its address contents accessed to be read from, written to or processed. The largest amount of data which can be moved together to be processed is called a **word**.

There are different types of computer memory. Let us look at some examples of computer memory and their features.

Types of memory

Random-access memory (RAM)

Inside a computer you will find one or more memory chips called **RAM (random-access memory)**. These hold the temporary operating instructions for the computer, its programs and the data. This is the place where the CPU receives the instructions and data it needs to do its job.

The advantage of RAM is that the computer can access data held in RAM almost immediately. The major disadvantage is that RAM is volatile – data held in RAM is lost when a computer is turned off or malfunctions. This is why we need to use other media to store data.

As computer programs and operating systems have become more complex, the size of RAM has increased. Most computers come with 2 to 8 GB of RAM as standard.

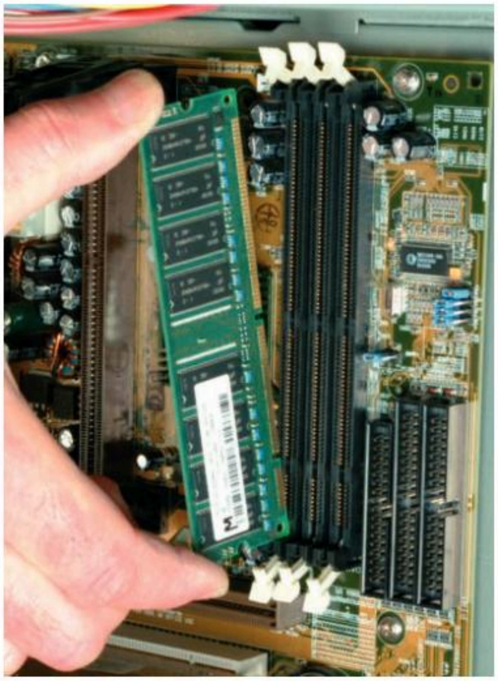


Fig 1.16 Random-access memory (RAM) – a close-up of a RAM memory module

Read-only memory (ROM)

When a computer is made, basic input/output instructions are put on **ROM (read-only memory)** chips. These instructions can be read, but not changed (non-volatile), and are available every time the computer is switched on.

Hybrid memory

Recently, as memory technology develops, the line between RAM and ROM has become blurred. Now, several types of memory combine features of both. These devices do not belong to either group; they are called hybrid memory devices. Hybrid memories can be read and written as desired, like RAM, but maintain their contents without electrical power, just like ROM. Flash memory is a variation of a ROM device that is typically used to store code.

How data is represented

Everything that the computer does results from the turning on and off of different combinations of microelectronic switches called transistors or **bistable devices**. The 'off' and 'on' states of the transistors are used to represent the zeros (0) and ones (1) that make up the binary number system. These zeros and ones are known as **bits** (binary digits). A bit is the smallest chunk of information or piece of data that a computer can work with – either binary 0 or binary 1. The more bits a processor can use, the faster it can compute (work things out) and the more memory it can access easily. When you use a computer, millions of switches are continually being switched on or off by an electric current.

A popular range of processors is the i5 or i7 series produced by Intel. The chip shown in Figure 1.17 is made up of over 27 million tiny switches (transistors) mounted on a slice of silicon.

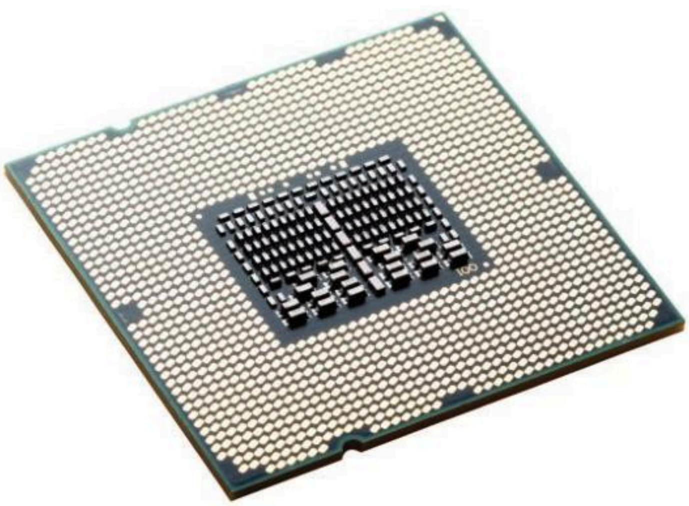


Fig 1.17 A close-up of an Intel i7 core processor

If you think of all of the programs on a computer, plus all the files that are saved, you can see that on each computer disk there are millions of bits. Computer memory and storage size is therefore given in **bytes** (8 bits make 1 byte), **kilobytes** (kB), **megabytes** (MB), **gigabytes** (GB) or **terabytes** (TB). 'Kilo' normally means a thousand, or 10^3. However, 1 kilobyte is 1024 bytes. This is because computers count by twos (binary) and powers of 2 and not in tens like humans. Therefore, 1024 is $2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2$, that is 2 multiplied by itself ten times.

Table 1.2 *Units of computer data storage*

1 kilobyte (kB)	$= 2^{10}$ $= 1024$ bytes
1 megabyte (mB)	$= 2^{20}$ $= 1024$ kilobytes $= 1024 \times 1024$ bytes $= 1\,048\,576$ bytes
1 gigabyte (GB)	$= 2^{30} = 1024$ megabytes $= 1024 \times 1024$ kilobytes $= 1024 \times 1024 \times 1024$ bytes
1 terabyte (TB)	$= 2^{40} = 1024$ gigabytes $= 1024 \times 1024$ megabytes

Questions

1. Describe the main purpose of the CPU.
2. What is the general name for each of the following types of memory:
   a. holds the temporary operating instructions for the computer
   b. instructions can be read, but not changed, and are available every time the computer is switched on
   c. can be read and written as desired, but maintains its contents without electrical power.
3. State the name given to the smallest chunk of information or piece of data that a computer can work with.

Secondary storage refers to the media and methods used to keep programs, data and information available for later use. Secondary storage saves programs and data permanently, whereas primary storage uses main memory, which is temporary.

Devices and media

Secondary storage media keep data, instructions and information on the physical hardware of a computer for future use. Examples are hard disks, compact disks and tapes. **Storage devices** record and retrieve data, instructions and information to and from storage media. Examples are hard disk drives, compact disk drives and tape drives. So hard disks are storage media whereas hard disk drives are storage devices.

It is very important to have media and methods to store data and programs when a computer is turned off. Secondary storage can be generally grouped into local storage and cloud-based storage.

Local storage

Local storage involves users having storage devices or media with data in their possession or generally knowing of their location. These local storage devices include:

- magnetic media such as magnetic tape and hard disks
- optical disks such as CD-ROM, CD-R, DVD and Blu-ray
- flash memory.

Magnetic media

The cheapest way to store and back up data is on magnetic media, such as magnetic tape and hard disks.

Magnetic tape

Backing up to tape is vital for computer networks and organisations or businesses which need to store important and large amounts of data for a long time.

Magnetic tape is a narrow strip of plastic coated with ferrous oxide. The data is recorded along the length of the tape, with each symbol encoded in binary form across the width of the tape. It is unique since data can only be retrieved in the same order in which it was stored. Therefore, retrieving the 50th piece of data means accessing 49 pieces that precede it. The tape drive winds the tape from one reel to another by passing the tape over a magnetic head to read, write or erase the data as it moves (Fig 1.18). Magnetic tape is used primarily as a back-up storage medium since access to data is not as rapid as with other storage devices. Since creating a tape backup is a slow process it is often done at night or at the end of a working day.

Fig 1.18 Backup tapes such as this are used to make copies of large amounts of data on computer networks

Hard disks

Another common device that stores data is a magnetic disk known as a **hard disk** (Fig 1.19). Although it is possible to add external **hard drives**, most are inside computers, protected by rigid cases. Technically, the hard drive is the machinery that controls the motion of the hard disks which contain the data. But most people use 'hard disk' and 'hard drive' interchangeably.

Fig 1.19 Structure of a hard drive

Hard disks are popular for use with computers and laptops since they store a large amount of data. Hard disks ranging from 700 GB to 1 TB in capacity are now common. External hard disks are now available in capacities and speeds similar to internal disks.

Optical disks

Optical disks can store much more data than most magnetic media. There are three basic types of optical disk. Compact disk drives are also known as optical disk drives because they use lasers to store and read data.

You will already be very familiar with one type of compact disk – the audio CD that plays your favourite music. There is, though, another type of CD that is used only with computers. This is known as the CD-ROM (Compact Disk Read-Only Memory). The CD-ROM allows you to access up to 650 MB of stored data.

Many computers with CD-ROM drives can play audio CDs, but the term CD-ROM is always taken to mean any CD format which stores data, rather than audio tracks. CD-ROMs are read-only media, which means that you can only use the data on the disks. CD-ROMs that contain software or programs are of the Write Once Read Many (WORM) variety. They cannot be changed once they are created. This is where the ROM part of their name comes from.

The major advantage of optical drives such as CD-ROMs is that they can store significant amounts of data. However, they can be easily damaged during handling and from exposure to light, heat or dust. Compact Disk Recordable (CD-R) and Compact Disk Rewritable (CD-RW) are types of CD that allow data to be written to (stored on) disks. However, the data on CD-RWs can also be erased. Many personal computers are sold with CD-R drives so that you can regularly back up data saved on hard disk.

Digital Versatile Disks (DVDs) are used for storing any kind of digital data and gaming software. They can store much more data than CD-ROMs, enough that full-length feature films can be put on DVD. They are known for replacing the VHS cassette tapes which were used to distribute movies, and as a result, DVDs are often referred to as digital video disks.

A DVD-Video holds video programs and is played in a DVD player linked to a TV or monitor. DVD-ROM, like CD-ROM, holds computer data and is read by a DVD-ROM drive linked to a computer. The massive storage capacity of DVDs, coupled with the fact that digital technology produces better pictures, are the main reason DVDs replaced videotapes.

Blu-ray Disks (BD) were designed to replace the DVD by storing several hours of video using a storage capacity of up to 100 GB. Its main use is for distribution of video game software and feature films that can be viewed in high-definition resolution.

Flash memory

USB (Universal Serial Bus) flash memory drives are also known as jump drives, memory sticks or flash drives, and can be convenient alternatives to

Fig 1.20 Optical disks can store large amounts of data and typically used for storing digital data, movies and gaming software

hard drives. Their storage capacity is typically 8 to 256 GB, although there are larger capacities available. They can be used for storage and data backup, but are mostly used for transfer of computer files, since they can store and transfer data faster than the CD and can be read by many devices.

Flash memory drives combine the best features of the memory devices described thus far. They store large amounts of data, are low cost, non-volatile, fast (to read, but not to write), and electrically reprogrammable. These drives have become increasingly common since they use a standard-type USB connection with computers and laptops.

Fig 1.21 Memory sticks provide additional storage, and are non-volatile and faster than most magnetic and optical storage media

Flash memory cards

These cards are inserted into digital cameras, video games consoles, laptop computers, MP4s, digital cameras, mobile phones and other music players. Mobile phones, for example, contain a Subscriber Identity Module, also called a SIM card, that stores the phone's unique number, along with data such as contact numbers and text messages. These cards vary in size, and their storage capacity ranges from 2 GB to 1 TB. The various devices, however, dictate the appropriate type and size of memory card it uses, so many are not interchangeable.

Fig 1.22 Flash memory cards vary in shape, size and capacity and can be used in a range of devices

Cloud-based storage

Cloud-based storage involves storage of data by users on multiple computers anywhere in the world. The exact location of this data is not known by its owners.

If you have used Facebook, Twitter, Instagram or YouTube, have an email address with Gmail or have used a mobile app, then you have probably used cloud-based storage already.

The **cloud** is an unlimited and powerful remote network of interconnected specialised computers. You can store your data such as school work, photos, email messages and videos at any time, from anywhere, once you have access to the Internet. This saves you from deleting data from your secondary storage device or transferring it to other storage devices to free space. When you use cloud-based storage, the data is not stored on a single remote computer somewhere in the world, but on lots of different computers. If one computer stops working, your data is still stored on another one.

Some cloud-based storage is free. For example, Dropbox and Google Drive give users access to about 15 GB of storage. However, businesses pay to have their data stored in the cloud for easy access and backup purposes. Users pay for the data storage, which can change as the amount of their data increases. You may never know where your data is stored, but you can access it using your computer or other devices and applications.

With cloud-based storage, millions of people from anywhere in the world can interact with the application at the same time. Access to data is immediate once they have access to the Internet.

As with any type of storage, there is always the risk of your data becoming accessed, deleted, stolen or corrupted, whether as an error or a deliberate act. Users with similar email addresses can receive each other's messages. Storing sensitive data in the cloud can also be a security concern.

Table 1.3 *Storage devices: advantages and disadvantages*

Storage	Advantages	Disadvantages
Magnetic media		
Hard drive Storage capacity: many gigabytes and getting larger	◆ Stores and retrieves data quickly ◆ External hard drives are portable	◆ Internal hard drives are not portable
Tape Storage capacity: many terabytes	◆ Used to back up data on hard disks ◆ Low-cost storage	◆ Not generally used with desktop computers ◆ Slow – so only used for network back-ups
Removable hard drives Storage capacity: many gigabytes and getting larger	◆ Removable and portable ◆ Relatively cheap	◆ Can be misplaced, or damaged since they are portable ◆ Need specific cable to connect to computer or device
Flash memory		
Storage capacity of USB memory stick: typically 8 GB to 256 GB Storage capacity of memory card: 2GB to 1 TB	◆ Compact shape ◆ Operates faster than an optical disk ◆ Can hold more data than an optical disk	◆ USB memory stick requires a USB port ◆ Some do not have write-protection ◆ Can be easily misplaced or stolen
Cloud-based storage		
Storage capacity: 15 GB for individual users of some applications. Limitless for others who pay for the service	◆ Users from anywhere in the world can interact with the application at the same time	◆ Data can be accessed, deleted, stolen or corrupted

(continued)

Table 1.3 *Storage devices: advantages and disadvantages (continued)*

Storage	Advantages	Disadvantages
Optical storage		
CD-ROM (Compact disk read-only memory) Storage capacity: 650 MB	◆ Very cheap to produce, particularly on a large scale ◆ Good way of distributing software	◆ As CD is read-only, data cannot be changed or deleted ◆ Slower access times than hard drives
CD-R (Compact disk recordable) Storage capacity: 650 MB	◆ Possible to add data (write) to the CD-R in more than one session ◆ Good for backing up files	◆ Should have a CD-R recorder to write to a disk ◆ CD-R software has varying capabilities
CD-RW (Compact disk rewritable) Storage capacity: 650 MB	◆ CD-RW can be erased and reused as many times as required ◆ Good for backing up files	◆ Should have a CD-RW recorder to write to a disk ◆ CD-RW does not work in all CD players
DVD (Digital versatile disk) Storage capacity: 4.7 GB up to 17 GB	◆ Excellent for showing video ◆ As with CD-R and CD-RW, there is a range of ways of writing (storing) data on DVD	◆ Has replaced CDs, producing better quality videos than CD-ROMs ◆ DVDs do not work in CD-ROM drives
Blu-ray Storage capacity: 25 GB up to 100 GB	◆ Blu-ray was intended to replace the DVD. Main use is for distribution of feature films and video games ◆ Can be viewed in a high-definition resolution	◆ Requires a Blu-ray player or optical drive ◆ More expensive than CDs and DVDs

Questions

1 State the general name for the type of storage that saves programs and data permanently.

2 List three categories of local storage.

3 What is the main use of magnetic tape?

4 What type of secondary storage is most suitable for use in digital cameras and mobile phones?

5 Explain one advantage of, and one concern associated with using cloud-based storage.

System software is the name given to the software that controls hardware and how all other software works. Examples of system software include operating systems and utility software.

Operating system

The most commonly used system software is called an operating system. Without an operating system, a computer would not work. Popular operating systems include Microsoft Windows 10, Apple's Mac OS X and many versions of LINUX. Popular mobile operating systems include Apple iOS and Google Android.

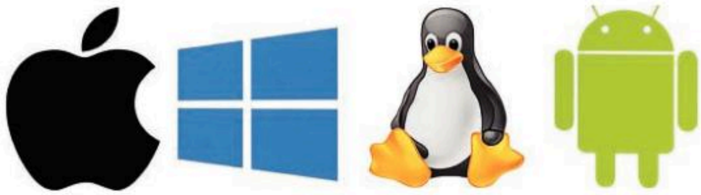


Fig 1.23 Common operating system logos: from left to right they are Apple, Windows, Linux and Android

Booting

The process of starting a computer is known as booting. The first thing a computer does when you turn on the power button is to check that it is working properly by following certain instructions held on a ROM chip known as the BIOS. It will then look for an operating system to tell it what to do next. The operating system is loaded from disk to the computer's random-access memory (RAM).

Hardware control

The operating system supports tasks like accepting input and transferring data between primary and secondary memory or displaying output. It also sets the rules for controlling hardware resources such as peripheral devices like keyboard and mouse, the amount of memory used, CPU time allocation and disk space used.

Software control

The operating system controls how all software applications, games or other programs work on the computer.

Memory management

When a program or data is too large to fit into main memory, a method called **virtual memory** can be used to split the program into manageable blocks. The required blocks are swapped between main memory and secondary storage to accommodate the program or data.

Input/output management

Since each device has a program called a **driver** that allows the device to communicate with the computer, the flow of information among devices must be managed and coordinated.

Process management

Process management allocates time for processes to use the CPU, checks on processes waiting to use the CPU, and signals when the CPU is available.

File management

Files need to be saved, copied, renamed and deleted. A file manager checks the amount of memory needed to perform these tasks and manages the organisation of the files in secondary storage.

Utility software

Utility software is specialised software that tries to protect and maintain the system software. Examples include protecting software against damage caused by computer viruses, backing up files and recovering files after software has stopped working (crashed).

Questions

1. Explain the purpose of system software.
2. Name one computer operating system and one mobile operating system.
3. State the name of the term that matches the following descriptions:
   - **a** the process of starting a computer
   - **b** a method used to split a program into manageable blocks.

Data must be processed by the most suitable means. It can then be transferred to one or more computer systems for more processing, for output or for storage.

Batch processing

A **batch processing** system is one where data is collected together in a batch before processing starts. Batch processing is most suitable for tasks where a large amount of data is processed on a regular basis. When a batch job begins, it will continue until it is completed, or until an error occurs.

Examples of batch processing systems include those that process utility bills such as water and electricity, payroll systems and examination report card systems. Credit card companies also process billing in batches. The customer does not receive a bill for each separate credit card purchase but one monthly bill for that month's purchases. The bill is created through batch processing, where all the data is collected and held until the bill is processed as a batch at the end of the billing cycle.

Advantages

- Once the data is submitted for processing, the computer may be left running without human interaction.
- Jobs can be scheduled for a time when the computer is not busy.

Disadvantage

- There is always a delay before work is processed and returned since batch jobs are usually stored up over a period of time.

Time-sharing

A time-sharing system allows many users to share time on a single computer. Each user is given a slice of CPU time by the computer. The computer works so fast that each user seems to be the sole user of the computer.

One example of a time-sharing system is a bank's bankcard system, which allows hundreds of people to access the same program on the mainframe at the same time.

Other operating system controls include:

- multi-tasking: allowing more than one program to run (work) at the same time: for example, using a desktop publishing program while a graphics program is still running
- multi-processing: executing programs using two or more processors simultaneously
- multi-programming: executing two or more programs at the same time using only one processor
- multi-user: allowing more than one user on a computer network to access the same file at the same time.

Online and real-time processing

Computers and peripheral devices are online when they are connected to a main processor and turned on, so that the operator can interact with them. Printers are online, for example, when they are ready to receive data from the computer to print. Most printers have an online button you can press to turn the machine on. If it is turned off, then you are offline. You can also be online if you are connected to, say, the Internet through a modem or network.

A real-time processing system processes data without significant delay, making it always up-to-date. Since a processing system must be connected to one or more computers to process data, then it must also be online. However, note that online does not necessarily imply that processing is real-time since there may be some delay with an online system. Examples of real-time processing systems include aeroplane landing control systems, electronic fund transfer systems and ticket reservation systems.

Advantages

- No significant delay for response.
- Information is always up-to-date.

Disadvantages

- The computer must be dedicated solely to the task.
- The computer must be continually online.

Data transfer

Most computer users will, at some time or another, need to transfer files between computers. School students may need to transfer their work from a computer at home to the school network via cloud-based storage, by using a secondary storage device such as a flash memory stick or by emailing the work to themselves to retrieve when they are at school. **Uploading** data involves transferring data from your computer to another computer on the network or the Internet, while **downloading** involves receiving data to your computer from another computer on the network or the Internet. Updates to software packages, such as Microsoft Office, are downloaded from the Internet using file transfer protocol (FTP) (see section 3.2).

Before transferring data, it is also sometimes necessary to reduce the file size. The process of reducing the size of a file for storage, or for sending via the Internet, is known as file compression. WinZip and Winrar are popular programs for compressing files. They can also be used to group files together into a single file for easier transmission. File compression is important because some files can take up a large amount of disk storage space.

The larger the file size, the longer it takes to send via the Internet. Users of the Internet will also know that web pages containing pictures can take a long time to load. Some popular file formats give smaller file sizes than others because they are a compressed file type (Table 1.4).

Table 1.4 *File compression*

Type of data to be compressed	Compressed file format
Graphics	◆ JPEG (Joint Photographic Experts Group): a common image file found on computers and the Internet ◆ PNG (Portable Network Graphic): a common image file format to find on a computer and the Internet
Music	◆ MP3: a digital audio file for listening to music on computers and digital media devices
Video	◆ Versions of MPEG (Moving Pictures Experts Group): MP4 files can also contain audio, video, images, and text data

Questions

1 State the most suitable type of processing mode for each of the following examples:
- **a** printing 400 cheques for employees' wages
- **b** a computer that can access the Internet
- **c** a printer is plugged in and turned on.

2 State the most suitable term for each of the following descriptions:
- **a** transferring data from another program to the one you are using
- **b** the process of reducing the size of a file and/or combining files for storage or transmission.

3 Suggest the most suitable compressed format for each of the following files:
- **a** a picture of a family
- **b** a video of a birthday party
- **c** a recording of a song by a school choir.

You have seen that an operating system such as Windows is essential for a computer to work. Most of the software we use regularly has been created to do specific tasks – for example, word processing or desktop publishing. The term for software such as this is application software or an application program. Application software is defined as any program that enables the computer to carry out one or more specific tasks.

General-purpose software

The most popular applications are those that are not specific to any organisation or business and can be used by anybody. The programs you use at school or home – for word processing, databases, spreadsheets, presentations, drawing and painting – will be such programs. These programs are known as general-purpose software, because the user decides what to use the software for. For example, you might want to use a word processor to write a letter, or to design a poster for a school play.

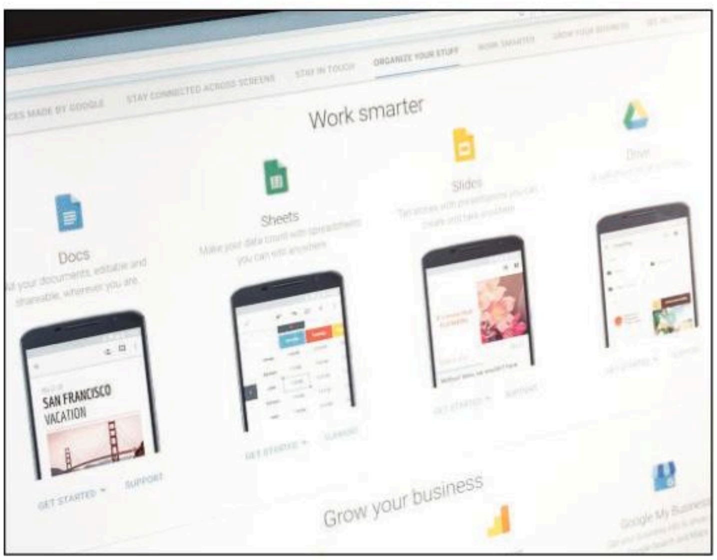


Fig 1.24 Data in online applications such as Google docs, sheets and slides can be updated in real time and shared with multiple users

General-purpose software is much cheaper because it has been used by millions of people over a number of years and is generally error (bug) free. Some applications are even available online, where information can be accessed anywhere or updated by multiple users at the same time. Popular examples of application programs (software) are given in Table 1.5.

Customised and custom-written software

Customised software is general-purpose software that has been modified to perform specific tasks for the user. Word-processing, spreadsheet and database programs are examples of general-purpose software that can be customised by automating certain parts of the software or writing and adding programming modules to perform specific tasks.

In contrast, custom-written software, which is also known as bespoke or tailormade software, is software written for use in specific organisations such as the military, in hospitals for medical equipment, or in banks and other financial institutions. It also involves specific training, since users need to be able to use it efficiently. Other examples of tailormade software include that used by air traffic controllers, who manage the flights of thousands of aircraft; accounting software; airline reservation software; and computer-aided design. These are not general-purpose, since the users of these kinds of software (for example, accountants and engineers) are trained in a particular field of expertise. Since this software is specific to an organisation or business it can be very costly to create and may take a long time to write before it can be used.

Specialised software

Specialised software is written solely for a specific task rather than a range of functions. Examples include the software on your mobile phone for your camera. It will only allow you to manipulate and share the photos. Another example would be an online card game, which would only allow you to play that particular game.

Integrated software

Many computers are sold with **integrated software** already installed. Integrated software is the term for a program that includes all the major types of application (for example, word processing, spreadsheet and database) and brings them together into a single **software package**. Microsoft Office and Adobe Creative Suite are examples of integrated software.

The large software companies such as Microsoft sell their main application programs together in one package. Although packages such as these are sold as integrated software, it is not true integrated software, as the programs are also still separate applications.

Choosing software should be no different from choosing any tool for a job. Just as in construction, you decide whether to use a drill or a hammer to carry out a particular task, so with software you need to decide what it is you actually need to produce, and then choose the most appropriate program. This is very important when choosing programs to use for your coursework.

Table 1.5 *Popular application programs*

Type of software	Examples of application programs	Purpose
Word processing	Microsoft Word, Google Docs	Writing letters, reports and other documents
Desktop publishing	Microsoft Publisher, Google Slides, Adobe PageMaker	Producing newsletters, leaflets and posters
Databases	Microsoft Access	Searching and sorting data
Spreadsheets	Microsoft Excel, Google Sheets	Commonly used for finance, budgeting and so-called 'number crunching'. Also used for creating models, simulations and 'What if?' queries
Graphics	Microsoft Paint, Adobe Photoshop, Adobe Illustrator, Adobe InDesign	Painting and drawing
Computer-aided design (CAD)	AutoDesk AutoCAD, DesignCAD	Producing detailed plans or models, often in 3D. Used by engineers and architects, e.g. for plans of buildings or in the design of cars
Integrated software	Microsoft Office, Adobe Creative Suite	All the major application programs – word processing, spreadsheet and database – are closely related and the output from the various programs can be transferred or embedded into each other with minimal errors
Presentation software	Microsoft PowerPoint, Prezi	Delivering slideshows and presentations to an audience – normally using a large screen

Questions

1. State the most suitable term for each of the following descriptions:
   - **a** software that is written for use in specific organisations
   - **b** software that is written solely for a specific task rather than a range of functions
   - **c** a program that includes all the major types of application.
2. Name two applications that can be used online and shared among users.
3. What type of application software would you use for:
   - **a** creating presentations
   - **b** monitoring weather patterns for the Meteorological Office.

User interfaces are found wherever digital technology exists. How you interact with and use this technology is controlled by the **computer–user interface**, also known as the human–computer interface (HCI). A user interface involves various ways of capturing or transferring data between a user and the computer system. The interface therefore can be graphical, text-based, or even audio–video-based, depending on the application, meaning that it can be a hardware interface, software interface or a combination of both.

Since a user interface helps the user to interact with a system, it should:

- have an attractive design
- be simple to use
- have a quick response time
- have instructions that are easy to understand
- have a consistent layout if there are multiple screens.

Hardware interfaces

Hardware interfaces such as touchscreens, sensors, digital cameras and special keyboards are input devices that were discussed earlier in the chapter. An example of a hardware device with a user interface is a games controller (Fig 1.25). The layout of the buttons, touchpad, joysticks and hand grips together form the user interface that carries out the various functions.

Fig 1.25 Hardware interfaces include games controllers with buttons that perform various functions

Software interfaces

Software interfaces are available after the computer has booted up and the operating system has been loaded, allowing the user to interact with the computer or device through an interface. Software interfaces include online forms for data entry, dialogue interfaces such as navigational systems in some vehicles and Amazon's Alexa on their talking Echo speaker unit. There are four main types of software interface:

- command-line interface
- menu-driven interface
- graphical user interface (GUI)

Command-line interfaces

Command-line interfaces require you to type in commands using a special language. This special language makes command-line interfaces difficult to use, especially for new computer users. In recent versions of Windows, it is called Windows PowerShell (Fig 1.26).

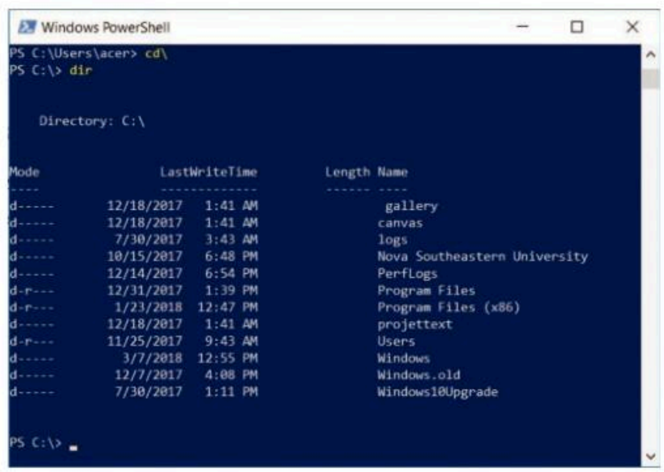


Fig 1.26 An example of a Windows PowerShell command-line interface

Menu-driven interfaces

A menu is a list of options from which you can choose what you want to do. Application programs use menus as an easy alternative to learning program commands. **Menu-driven interfaces** were developed to try to make the interface friendlier and easier to learn. You can control the computer by choosing commands and available options from a menu, using the keys on a keyboard or a mouse. For example, depending on your choice, another set of options may appear on the screen for you to make another choice (Fig 1.27). This continues until you reach your final selection.

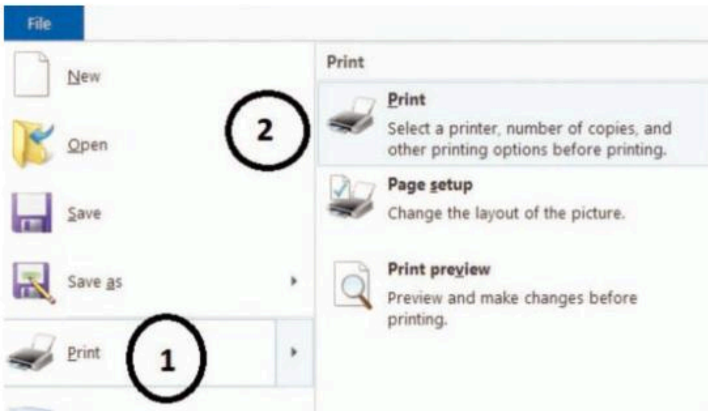


Fig 1.27 Menus allow you to make a series of choices from a list which produces another list until your final selection

Menu-driven interfaces can also be verbal rather than visual. An example is an automated answering service, where you press 1 on the keypad for a department, 2 for another department, or 0 for the operator. These interfaces can be easy to follow but can become confusing as the number of menu options increase and you need to retrace your previous options.

Graphical user interfaces

All computers are now supplied with a **graphical user interface (GUI)** installed because it is presently regarded as the type of user interface which is easiest to use. The main features of a GUI include its ease of use for beginners, and ability to cut and paste or 'drag and drop' data and files among applications. However, GUIs require a lot of memory, which can slow processing time. Sometimes simple tasks take longer than necessary because of the number of functions or steps required.

A GUI comprises Windows, Icons, Menus and Pointers also called **WIMP**. Figure 1.29 shows an example of a GUI with icons and menus on the computer desktop.

Windows

A window is a part of the screen that holds its own document or message. Most computers now use window-based programs (Fig 1.28). A window can take up the whole screen or can be resized, moved or shrunk (minimised). Each time you open a **folder**, you see its contents in a new window. More than one window can be open at the same time. This is particularly useful if you want to move from one window to another or to copy files from one window to another.

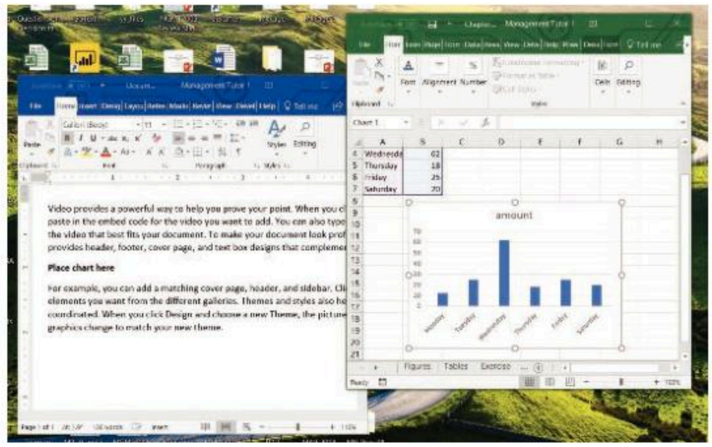


Fig 1.28 An example of two window-based programs (word processor and spreadsheet program) that are open at the same time

Icons

An **icon** is a tiny picture of an object that is displayed on screen (Fig 1.29). Normally, you can use the icon in some way. For example, by using the mouse to double click on the icon of the Microsoft Excel spreadsheet program, you will start the program.

Fig 1.29 Icons allow you to easily recognise programs in a graphical user interface (GUI)

Icons are designed to make things easier for computer users. Instead of having to remember commands, all you have to do is remember what the icons look like. Icons are not just for programs. There are icons for folders, the recycle bin (wastebasket), disk drives and printers.

Menus

An advantage of using menus in Windows or on a Mac is that, for most programs, the first few menus are always in the same order. They also carry out the same functions, no matter which program you are using. For example, the file menu is first and enables you, among other things, to create, save and print a document.

Pull-down menus are activated by clicking on the menu item (such as 'File') using the left mouse button. The menu pulls down just below the menu item, and you can scroll down through the various items. More complicated pull-down menus can produce additional pull-down or pop-up menus.

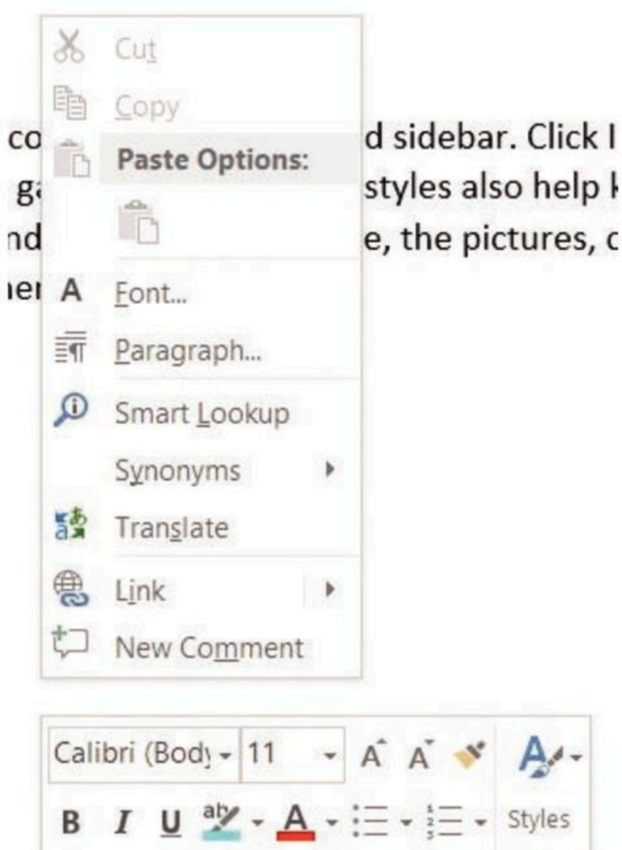


Fig 1.30 A pop-up menu from Microsoft Word

Pop-up menus (Fig 1.30) are activated by clicking anywhere on the document screen using the right mouse button. Some standard commands and options are available on these menus, including the cut, copy and paste commands.

Pointers

The most common pointing device is a mouse. As the mouse is moved, a pointer moves around the screen. The pointer is a very important part of a GUI, as it enables you to control the computer and to choose window items, to select text in a document or cells in a spreadsheet, and to create drawings and shapes. Other pointing devices include, graphics tablets, joysticks and digital pens for use with touchscreen devices.

Improving interfaces

Software companies spend a great deal of time and effort trying to improve the interface so that the computer is easy to use. An important part of this is to design the system software and application programs so that they work exactly the same way each time they are used, and the menus are always in the same place.

People use computers for many hours a day. Therefore, the screen design and screen colours must be visually pleasing and soothing. However, some colours might be impossible for the visually impaired to see, therefore audio hardware interfaces have become useful.

Questions

1. For each of the following, indicate whether it is a hardware interface, software interface, or a combination of both:
   - **a** display screen on a printer
   - **b** pressing a code on a keypad to open a door
   - **c** shouting a command to a device which responds with certain actions.
2. Explain what would cause a menu to confuse a user.
3. State what the following terms mean:
   - **a** WIMP
   - **b** GUI.

We need computer systems in almost every aspect of human life: from preparing meals, to maintaining cars and travelling to work or school. For example, a control system uses machines to accept input as instructions to produce output, such as changing the red, amber and green of traffic lights or a moving a robot arm to pack eggs. A communication system usually transports data through the network from one point to another. A computer information system is responsible for the collection of data, its processing into information, and the overall management and distribution of this information.

Computers and communication devices can therefore manage large amounts of information at a faster rate than manual systems, such as filing, sorting and mailing.

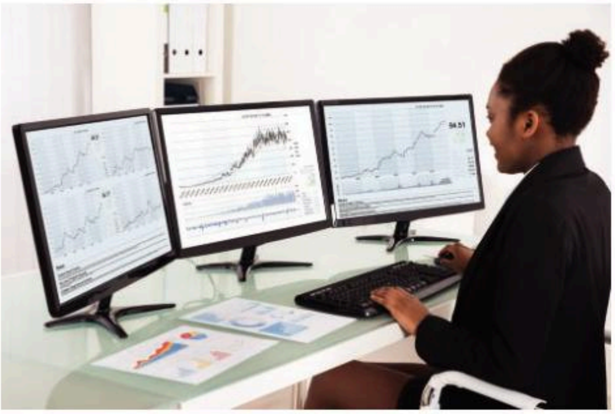


Fig 1.31 Information systems are now an essential part of office work

When choosing a computer information system for a particular application, you need to consider:

- what hardware is used, such as input, storage and output devices
- what software is used, including the choice of custom-written, general-purpose and specialised software
- what processing takes place
- what human–computer interface is used
- which people are involved and what work they do
- what data is required.

The first four points were discussed earlier in this chapter. You can now apply this knowledge to decide which systems and applications are appropriate in various computer-related fields based on their input, processing, storage and output needs.

Types of computer systems

Computer information systems can be chosen to suit different users and tasks. They are also classified by their processing speed, storage and portability.

Mainframe

This term originally referred to the cabinet containing the CPU or 'main frame'. **Mainframes** are very large capacity computers with several CPUs, capable of supporting hundreds or even thousands of users simultaneously. Those such as the IBM zEnterprise mainframe are built with spare components to prevent breakdowns. Data flows between peripherals and communication devices. Users may connect to the mainframe remotely, and only the system administrators will have direct access to the physical computer. Primary and secondary storage are therefore extremely large. Organisations such as banks, airlines, universities and government departments use mainframes – they are very expensive to buy, and need full-time staff for their operations, maintenance and upgrades.

Desktop systems

Also simply called a computer, a **personal computer** or **desktop system** (Fig 1.32) fits on an office desk. It is easy to buy, upgrade and maintain. Its tasks are for a single user. Memory sizes are increasing but it is not uncommon to find primary storage sizes of 8 GB (RAM) and hard-disk sizes of 1 TB. Most computers now contain multiple processors (CPUs) working at speeds of 3 GHz. Their main use is for office and school work, games and entertainment, Internet access and data communication (including email).

They can, however, be linked in a network with more powerful computers.

Fig 1.32 A typical personal computer

Mobile devices

Mobile devices (also called handheld devices) include laptops, notebooks, netbooks, tablets, smartphones, e-readers and games consoles. They are similar to personal computers but are smaller, lighter and contain batteries so that they are not restricted to being connected to electrical outlets.

Embedded system

An **embedded system** is a dedicated computer system that is designed for one or two specific functions. These systems are therefore embedded as a part of a complete hardware device called an embedded device. They consume very little processing power and may or may not be able to connect to the Internet. The main aim is to increase the reliability and performance of the device. Embedded devices can be found in digital watches, printers, washing machines, banking ATM machines and even four-wheel drive vehicles and large installations such as traffic lights. Some embedded devices have no user interface, while others may use simple menu systems or touchscreens.

Questions

1 State the most suitable type of computer for each of the following descriptions of computer systems:
   - a used by secretaries for general office work
   - b very large capacity computers with several CPUs
   - c consumes very little processing power and may or may not be able to connect to the Internet.

Troubleshooting basic computer problems

A number of simple problems can occur when using a computer, but a few checks can be performed to identify the possible cause(s). These checks can determine whether the problem can be rectified immediately or if there may be a need to seek further technical assistance.

Computer, laptop or mobile device does not respond when power is turned on

1. Ensure that the power cable is connected to the power connector on the back of the computer or device and plugged into the electrical outlet.
2. If it is plugged into a power strip or surge suppressor, check that the power strip is connected to an outlet and turned on.
3. Make sure that the electrical outlet is working. This can be done by testing it with another device such as the monitor or a printer.
4. Briefly bypass the surge suppressors, power strips and extension cables in turn, which connect the computer directly to the power outlet, to verify that the computer turns on.
5. Try using another power cable that is suitable for the device. If the power turns on, then the cable needs replacing.

Printer problems

1. Ensure the printer driver is installed on the computer.
2. Ensure that the printer is plugged into a power strip or outlet and the printer is turned on.
3. Check that paper is not stuck in the printer. Open the printer and remove the component that holds the paper. You may need to remove the ink or toner cartridge to see if paper is stuck under the cartridge. You may see an error message on the monitor or the printer lights may indicate what the error could be.

Printer is receiving power but is not printing correctly

1. Ensure the printer contains one or more ink cartridges or that the correct toner is installed.
2. If the print quality is poor, the ink or toner cartridge may need to be replaced.
3. Ensure printer settings for ink cartridge alignment, paper orientation, margins are correctly set.
4. If the print quality is low, check the print quality being used – options are provided to set the quality of print being used from the printer. Draft, Normal and Best are examples of print quality you may see for an inkjet printer.
5. Some printers use Wi-Fi, so check on the display panel to see if the printer's Wi-Fi is connected.

If no paper is seen when you try to print

1. Ensure no parts of the printer are open.
2. Check that paper is correctly placed in the printer.
3. Verify that the correct data cable is being used, and the cable is connected to the computer and the printer.
4. Ensure that you have selected the correct printer. Several printers may be installed, and you must choose the required printer in the print dialogue window (Fig 1.33).

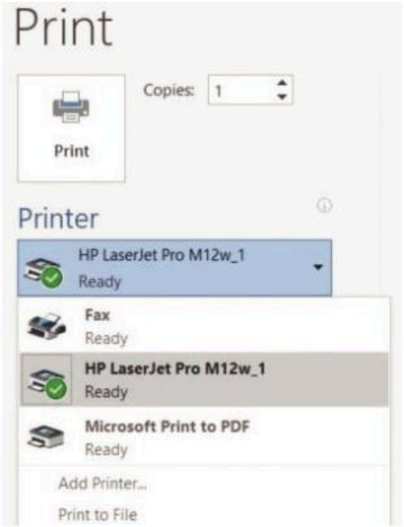


Fig 1.33 Check that the correct printer has been selected

Printout is blank

1 Change the ink or toner cartridge
2 If the problem persists, seek further technical assistance since the nature of the problem may require an experienced technician or a new printer.

Monitor problems

Blank screen

1 Check the monitor power light – if it is off, then press the button to ensure that the monitor is turned on. If the power light is on, then the monitor has power. Alternatively, if the monitor light is blinking or in a different colour, then the monitor may be in power save mode. Press a key on the keyboard or move the mouse.
2 Check the monitor cable connections. Check to ensure that the monitor power cable is connected to an outlet, power strip or surge suppressor. Check the monitor data cable is connected to the computer correctly.
3 Ensure the electrical outlet is working by testing with another device.

Screen difficult to read

1 Monitor settings may need to be adjusted (such as colour, contrast or brightness).
2 Ensure that no strong sources of magnetism are near to the monitor – such as speakers and amplifiers.
3 Monitors should be kept away from external power sources such as fans and fluorescent lamps and radios. These can cause the screen image to appear to vibrate. Nearby power sources should be turned off to check for interference.
4 Monitors facing bright sources of light such as windows and lights can make the images difficult to see. The monitor should be turned away from strong light sources.

Battery problems

For laptops and mobile devices, check the amount of charge in the battery. Move the cursor arrow over the battery icon while the laptop is connected to power adapter to view the remaining charge. Figure 1.34 shows some phases of battery use.

Fig 1.34 Different phases of battery use

The battery may need charging or replacing if:

- the laptop or mobile device shuts off when the power adapter is unplugged
- the device powers off soon after use
- the battery icon indicates that a battery is not detected or found.

Try another cord of the same make and model. If the battery charges then the power cord may need replacing.

Questions

1 You have been watching YouTube videos on your phone for about 45 minutes, then your phone suddenly powers off. Give one possible cause for this problem.
2 You found a printer cartridge still enclosed in its packaging. Since your printer needs ink, you decided to replace your empty cartridge with the one you found. However, the printer still does not print on the paper. Explain why this problem may occur.

Multiple choice questions

1 Which of the following enables a computer to temporarily store instructions and data?

a hardware
b input devices
c memory
d peripheral devices.

2 Which of the following controls the hardware and how all other software works?

a application software
b computer programs
c operating system
d peripheral devices.

Questions 3 to 5 are based on the following devices:

i keyboard
ii keypad
iii touchpad.

3 Which of the devices contains only a block of buttons that contain digits and symbols?

a **i** only
b **ii** only
c **iii** only
d **i** and **ii** only.

4 Which of the devices is not suitable for the visually impaired?

a **i** only
b **ii** only
c **iii** only
d **i** and **ii** only.

5 What is the main method to use these devices?

a Laser
b Light
c Sound
d Touch.

Questions 6 and 7 are based on the following printer types:

i dot matrix
ii laser
iii thermal.

6 Which of the following are non-impact printers?

a **i** only
b **ii** only
c **i** and **iii** only
d **ii** and **iii** only.

7 Which printer uses ink that fades over time?

a **i** only
b **ii** only
c **iii** only
d **i**, **ii** and **iii**.

8 Each of the following has its screen integrated with the system unit and keyboard ***except***:

a personal computer
b laptop computer
c mobile phone
d notebook computer.

9 Which of the following systems relies on precisely positioned marks on a form?

a EPOS
b MICR
c OCR
d OMR.

10 Which of the following holds the temporary operating instructions for the computer, its programs and the data?

a ALU
b CPU
c RAM
d ROM.

11 The process of starting a computer is known as:

a memory management
b software control
c booting
d crashing.

12 The MPEG file format compresses which type of data?

a graphics
b music
c text
d video.

13 Software that is made for use in specific organisations is called:

- **a** customised
- **b** custom-written
- **c** integrated
- **d** specialised.

14 The type of interface that allows a user to interact with a computer or device using a touchscreen is:

- **a** graphical
- **b** hardware
- **c** menu-driven
- **d** software.

Short answer questions

15 Explain the meaning of the term 'IPOS cycle'.

16 Complete the following sentences by using the most appropriate device from the list:

- **a** A ___________ records voices for presentation software.
- **b** A ___________ controls multimedia projectors.
- **c** A ___________ is used to type data for a document.
- **d** A ___________ reads information from a smart card.
- **e** A ___________ is used in flight simulators.
  - **i** remote control
  - **ii** microchip reader
  - **iii** joystick
  - **iv** graphics tablet
  - **v** keyboard
  - **vi** microphone.

17 Categorise each of the following examples as either (D) a storage device or (M) storage media:

a **b** **c** **d**

18 Circle the most appropriate term in each of the following statements:

- **a** When data is retrieved from sequential/direct access storage devices, the device will start from the beginning of the data to be read from, and proceed in a sequence, until it reaches the required data.
- **b** An example of a direct/sequential access storage device is a hard disk drive.
- **c** Direct/Sequential access storage devices access data immediately without having to read data from the beginning through to where the data is located.

19 Figure 1.35 illustrates an access device. Data is stored at each position on the device.

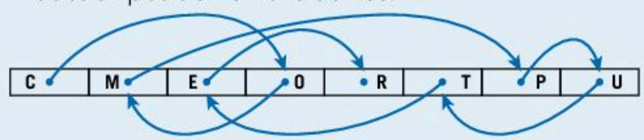


Fig 1.35

- **a** Starting from the first position at the left and moving to the right, write the letter found in each position.
- **b** If the data is accessed from the first location (**C**), follow the arrows and write the output in each position.
- **c** If the positions were numbered from 1 to 8, what would be the output if the data was accessed in the following order:
  - **i** 6783
  - **ii** 82567.
- **d** Circle the appropriate response:
  There is no order/a specific order to how the data is stored on the device.
  The diagram is illustrating serial/random access or sequential/direct access to the data.
  The speed to access data on this device would be fast/slow.
  A DVD/magnetic tape is most suitable for this type of access.

CHAPTER 2

INFORMATION PROCESSING

2.1 Data and information

Data is raw, unprocessed facts. For example, the numbers 26, 29 and 30 represent data. We do not know what the three numbers represent – they could mean just about anything – such as the temperature in degrees Celsius, the dates of interschool sports events or even the number of students in three classes. **Information** is processed data. The three numbers can therefore indicate what type of clothing to wear to keep cool based on the temperature, how close the exams are, or how many exam papers to print for each class.

Data processing is the manipulation of data to obtain information. So, taking one of the examples above, finding the average of the three numbers gives an indication of how warm the days have been.

The term **information system** is given to any record-keeping system. We come across information systems all the time. Common examples of manual information systems are dictionaries and telephone directories. What these examples have in common is that data has been collected (input), processed and displayed (output) in order to provide useful information.

Information is collected for the purposes of culture, leisure, work, research and everyday life. In organisations, however, it is mainly used for planning and decision making. There are many sources of information, including, for example:

- measurement: sales, productivity output, cash receipts
- formal and informal communication: word of mouth, meetings, announcements, interviews
- publications: hurricane-preparedness tips, research, daily newspapers, media reports and trends in chronic diseases
- questionnaires: opinion polls and market research
- products: labels containing ingredients, quantities, contents origin and dosage.

The value of information can include the cost of production, the cost of distribution and the value to the purchaser. The more valuable the information is to the customer, the more the organisation can charge for it. Also, customers may be willing to pay more to get information quickly.

With the rise of the Internet, two elements in this value chain have changed. The cost of distributing information has been reduced dramatically for web providers. Also, 'free' information may have additional value. An online newspaper story may include graphs or pictures and links to other stories on the same topic.

Once information is collected, it is often communicated directly to the person who wishes to use it. In order for it to be useful, information must be:

- relevant: it must be what the user needs to know, and be up-to-date
- accurate: it must be as correct as possible
- timely: information should be provided for problem-solving before a critical stage is reached and opportunities are lost
- complete: it must represent a 'whole' picture of a problem or solution

- in an appropriate medium: it should be delivered using an appropriate communication medium, whether by printed material or storage device
- cost-effective: the value of information should be more than the cost involved in its collection.

Information as a commodity

An information commodity is an item of information that can be bought or sold. For example, with online information you may have to pay a charge every time that you access that information.

The major types of information for sale are:

- databases, especially banking and other financial information that give demographic, tracking and buying trends
- information retrieval systems such as abstracting and indexing services
- full text databases and reference materials such as encyclopaedias
- other, less formal, publications such as subject-specialised bulletin boards, which in some cases may replace the more traditional journals.

Questions

1. Explain what is meant when data is said to be relevant.
2. Name two characteristics of data, other than relevance, that would determine if it is useful.
3. What is the term given to an item of information that can be bought or sold?

A common problem with manually entering data into a computer system is that it is very easy to input incorrect data. Examples include users mistyping a name or address in a database so that letters are sent to the wrong person. However, it is also possible for a device to misread a barcode and therefore not provide any information to the user.

Errors

Errors occur in any computer information system. There are several approaches to dealing with the problems that errors cause, specifically preventing errors (so that they do not occur) and detecting when errors do occur (so that they can be corrected). Below a few approaches are considered.

Data entry errors

Sometimes data cannot be automatically scanned into the system for storage, so a common way is to type the data directly into the computer system. Data entry errors, such as transposition errors, would then occur when an operator enters data using a keyboard and mixes up digits and/or letters. For example, the number 32 may be entered as 23. Other errors occur when data entry requirements are not clear. Do you interpret 07/01/2019 as July 1 2019 or 7 January 2019? These data entry errors can be either accidental or deliberate.

- Accidental errors occur unintentionally: data is entered or a command is issued by mistake, in good faith, but in error.
- Deliberate: if errors are made deliberately, then the user probably knows enough to get around any validation checks. Examples include a disgruntled employee entering fictitious data into a company's database. Possible solutions to this problem include file access permissions imposed by the operating system, better vigilance of the administrator and the cross-referencing of data with other supposedly reliable sources.

Software and hardware errors

There are two types of error here. Software might malfunction, erasing or corrupting previously entered data. Hardware may develop a fault (often intermittent) that corrupts data. Examples include bad sectors on a hard disk, bad memory or a power surge. The application may appear to accept data correctly but when that data is retrieved it is corrupt.

Transmission errors

Transmission errors occur when data received is not the same as that transmitted by the sender (Fig 2.1).

This is a message --------------→ &*#Q(#W%)@&*!

Fig 2.1 Illustration of transmission errors

Validation

Data validation is the computerised checking of input data for errors (data that may be unreasonable or incomplete) before it is processed. It does not confirm the accuracy of data. There are different methods of validation. The most appropriate method(s) to use will depend upon what data is being entered.

Range check

Range check ensures that the data entered is within a certain range. For example, when you enter a number corresponding to a month of the year, the range of acceptable numbers is 1 to 12.

Reasonableness check

This check tests whether the data obeys specified criteria. For example, the age of a child at preschool could be about 4 years old, but not 14 years. Reasonableness checks are therefore used to detect doubtful data.

Data type check

This is also known as a character or alphanumeric check. When a database is created, each field will accept a specific type of data. Whenever data is entered into a field the database will check that it is of the correct type, for example alphabetic or numeric. If it is not, then an error message will be displayed, and the data will have to be re-entered.

Table 2.1 *Examples of valid and invalid data types*

Field name	Type	Valid data	Invalid data
Date of birth	Date	19/10/1994	19/19/94, or 23
Percentage mark	Numeric	56, 99	A+, Pass, 125, –15

Notice that a type check is not a very good validation check. There are many entries you could put in the 'Valid data' column in Table 2.1 that would pass the type check but are clearly incorrect.

The data type check is particularly important if a fixed length field is defined to store the data. Any extra characters that exceed the maximum length would be lost. Length checks are usually only performed on alphabetic or alphanumeric data.

Table 2.2 *Examples of valid field lengths*

Field name	Maximum length	Valid data	Invalid data
Student ID	6	826025	82–60–45
Grade	2	B+, C	A++, Fail

Consistency check

A consistency check compares the contents of two or more fields to make sure that they make sense. It is also called an inconsistency check, since it mostly identifies errors and discrepancies in the data. This check compares new data with previously entered data. For example, checking that the age entered corresponds to the age calculation from the date of birth. Consider the following employee record:

Employment Status Form	
Are you unemployed?	No
Unemployment benefits claimed?	Yes
Number of years working	12
Current occupation	Foreman

It would be useful to have a consistency check to cross-check the information in the 'Are you unemployed?' and 'Unemployment benefits claimed?' fields, since you should not claim for unemployment benefits if you are still working. In this example, therefore, either an error has been made on input or this is a deliberate attempt to claim benefits while still working. Other examples of consistency checks are:

- Single mothers with children can claim for childcare allowance. Check that the number of children is not zero.
- Only full-time employees are paid overtime. Check that these fields correspond.

Presence check

This type of check ensures that the data is actually entered. It can be used on any field in a database. For example, every person in a particular database must be assigned to a department. Therefore, a presence check on each employee's record could ensure that a department is entered in the form.

Format check

This check verifies that the data has been entered in the correct format. For example, a national ID number may have the format 999-9999-X999, where 9 represents a number and X represents an alphabetic character.

Length check

This check verifies that the data entered is the correct length. For example, a password for a credit card may be four digits long, therefore entering three or five digits may result in an error.

Check digit

A check digit is an extra digit added to the end of a code. It is used to detect errors arising from transcription and also to ensure that codes originally produced by a computer are re-entered into another computer correctly. It is calculated from the other digits in the number. Check digits are included in barcode numbers.

ISBN 0-19-832844-3

9 780198 328445

Fig 2.2 A barcode showing a check digit

Verification

Data verification is the checking for mistakes such as transcription errors when data is copied from one medium or device to another. Verification checks do not guarantee that the entered data is correct, it only checks that the data entered matches the source data. Therefore, you should be aware that if the original form was completed incorrectly, then the entered data may pass some verification checks despite being incorrect.

One way to guarantee that the data entered matches the source data is a procedure called **double (data) entry**. Data is entered twice using a program that checks each second entry against the first. For example, some applications require users to enter their password twice. The application compares the two passwords to confirm that they are the same. In other applications where there is more data to be entered, the program produces a list with the pairs of data that do not match so that the correct values can be re-entered.

Visual checks

Another verification method is to use on-screen prompts. After a set of data is entered, it is redisplayed on the screen. The user is prompted to read it and confirm that it has been entered correctly. If the user has entered any data incorrectly, it is re-entered.

This method of verification is not very reliable since many data entry personnel will not read the information that is redisplayed or check it carefully against the source document. Accidental errors can also be prevented by verification in asking for confirmation of instructions. For example, if you try to delete files the computer may ask 'Are you sure [y/n]?' or it may display a summary of input data and ask for verification of its validity before the data is stored.

Interpretation of coded data

Before the responses to questionnaires can be analysed, they must be edited and coded before the data entry process. The person coding these responses should have no doubt as to what should be entered. This may sound simple, but consider the following case (Fig 2.3).

Is this your first visit to the country? Yes ☒$_1$ No ☐$_2$

Fig 2.3 Coding involves assigning a label to each question

Coding involves assigning a label to each response, such as 1 for 'yes' and 2 for 'no'. Sometimes, people will write in a response such as 'can't remember' or 'unsure', and you must decide what to do. It could either be ignored, or a new code and value could be added to the question.

As another example, consider a library database where books are classified as being Fiction, Non-fiction or Reference. This information could be stored as text in a database where the corresponding field length would be 11 to store the longest classification, 'Non-fiction'. Alternatively, the classifications could be coded like this:

Classification	Code
Fiction	F
Non-fiction	N
Reference	R

Coding information reduces the amount of storage space required and speeds up the process of typing the information in. For coding to work properly everyone needs to know what the correct codes are.

Problems associated with shared data

In organisations, information is constantly sent and received among various departments. Traditionally, if two people need to use the same file, the first person who found the file (in the filing cabinet!) made use of it; the other person waited until the first returned the file to the drawer. Computers and networks mean not only that neither person has to search through a drawer to locate the file, but also that both persons may access the data file at the same time. At least, it may appear in that way. Is this a good way to access data files?

Let us suppose that two teachers were both accessing a data record for the student Amerra Taitt (Fig 2.4). One teacher wishes to adjust the mark received in IT from the original 69% to 96%. The second teacher wishes to adjust the mark received in Geography from 18% to 81% (typo errors in both subjects!). What happens when the records are saved to the main database? Will both changes be accepted?

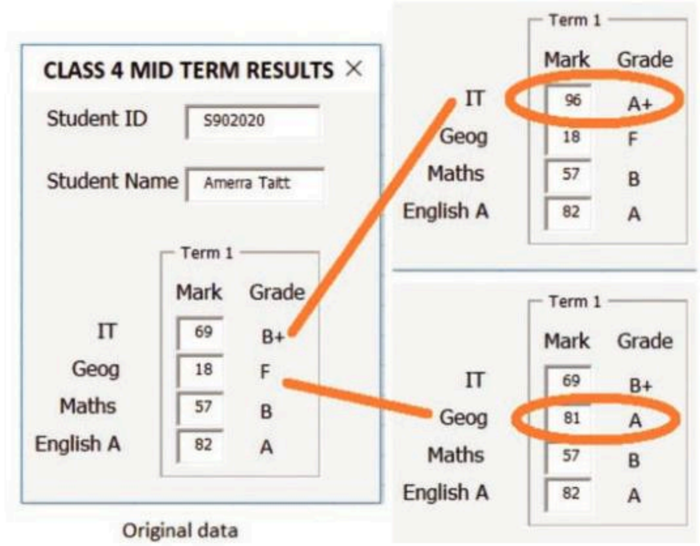


Fig 2.4 What happens if two people want to change data at the same time?

Data-sharing in this manner can lead to problems of data accuracy when the data records are saved. The teacher who saves the changes first will have the marks overwritten by the teacher who saves the changes last, which of course will erase the changes made by the first teacher. How can this problem be avoided?

Fig 2.5 A well-structured database will prevent simultaneous access to the same database record

Good databases avoid this problem by allowing only one user or system to access a data record at a time. When an attempt is made by a second person to access the same record, a message may be provided (Fig 2.5).

Computer systems that provide shared access to data must have security features in place. This prevents users from gaining access to data which they are not authorised to view or modify. The users of the computer system should be provided with their own usernames and passwords for the login process. There are also access privileges depending on the user's level. For example, a student at the school will be allowed access to certain software such as word processing, perhaps email facilities and limited Internet access. A clerk will have access to student records, personnel records, Internet access, email, and payroll programs. The network administrator will have the highest level of access, including data records of usernames and passwords and the network administration and security software.

Questions

1 Explain the difference between data validation and data verification.

2 Give an example of a data-related hardware error.

3 Copy and complete the table below by giving an example of valid data for each item:

	Field name	Acceptable values	Example of valid data
a	Opening hours	8 am to 4 pm	
b	Bulk orders	>250	
c	Standard shipping	3 to 5 days	
d	Centre number	999999 where 9 represents a digit	

Many of the output devices discussed in Chapter 1 are human-readable, meaning that a hard copy of the output is printed as reports, graphs, charts and so on. Other devices are machine-readable, meaning that the output is in a form that only a computer can process. An example is output to a monitor. This is called soft-copy output since it is not printed on paper or other physical material.

Data-capture forms

These forms must be designed so that their instructions are clear and concise, leaving no doubt as to how to enter the data onto the form. For example, the format for dates could be specified as 'dd/mm/yyyy' so that the format 'mm/dd/yy' is not used in error.

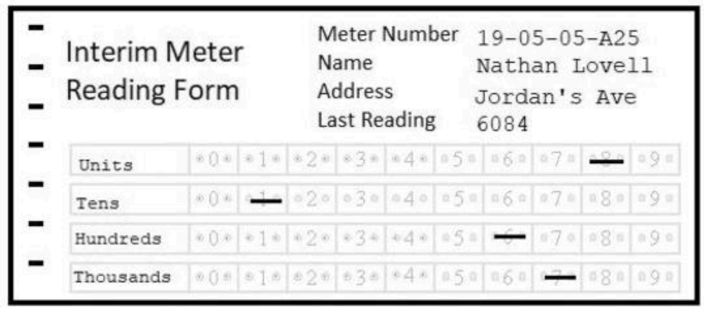
The responses from the forms are called human-readable since data entry personnel manually enter the responses written on the forms. This method of data capture is liable to transcription and other errors when the data is entered into the computer. One method of avoiding transcription errors is double (data) entry, where the data is entered twice by two different people and the computer will only accept the data if the two versions are identical.

Turnaround document

A turnaround document is a machine-readable document that has some information printed on it by a computer but has more information added to it by a human. It is then fed back into a computer to transfer this newly added information. These documents serve two purposes. They are used to:

- verify the accuracy and completeness of information that has already been entered
- update information already entered with additional data.

Optical mark recognition and optical character recognition are often used together in a turnaround document. Figure 2.6 shows an example of a turnaround document used to record the reading on an electricity meter.


Interim Meter Reading Form

Meter Number 19-05-05-A25
Name Nathan Lovell
Address Jordan's Ave
Last Reading 6084

Units	0	1	2	3	4	5	6	7	8	9
Tens	0	1	2	3	4	5	6	7	8	9
Hundreds	0	1	2	3	4	5	6	7	8	9
Thousands	0	1	2	3	4	5	6	7	8	9

Fig 2.6 The meter reader has marked the reading as 7618 on this turnaround document

Another example of a turnaround document is the multiple-choice sheets used in examinations. Information such as the candidate number, subject and school code is printed on the multiple-choice answer sheet by the computer. The student takes the test and fills in the answer grid by making marks in the appropriate boxes using a pencil or ballpoint pen. The form is then returned to the examination council to be fed into a special reader.

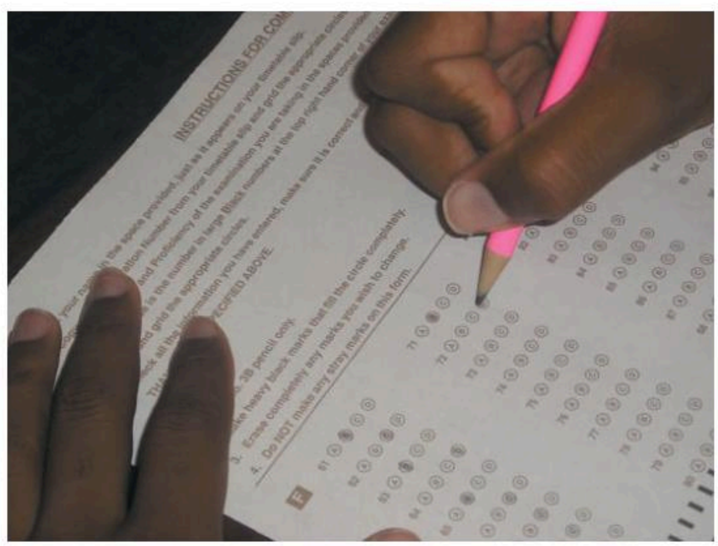


Fig 2.7 Multiple-choice exam sheet

Optical character recognition (OCR) is used to read the student's pre-printed information from the form, whereas optical mark recognition (OMR) is used to read the answers that have been added. All the information can be read into the computer automatically. The sheet is marked, and the total mark is printed without any need for human intervention.

Turnaround documents allow cheap, fast input of information into a computer system. Data can also be printed on turnaround documents in barcode format.

Alternatives to turnaround documents

In some industries, turnaround documents are being replaced by small handheld computers, including mobile devices. These pocket-sized devices have a display screen and touchscreen keyboard. For example, many local utility companies now issue their meter readers with handheld computers. At the start of the day the names and addresses of the customers to be visited are downloaded into the computer. As the meter reader visits customers' homes, he or she types the meter readings into the computer. At the end of the day the readings can be transferred automatically onto the main computer to issue bills. Another example involves courier services that equip drivers with these devices. As the courier delivers a package, the recipient uses a stylus to sign the delivery document on the device. This signature is captured digitally and uploaded to the database as proof of delivery.

Fig 2.8 Turnaround documents are being replaced by small handheld computers

Data logging

Computers are often used by companies and scientists to automatically measure and record changes in conditions such as the temperature, the speed at which a ball is travelling in sports such as cricket and baseball, the amount of light or oxygen in a room or even the level of noise being made by vehicular traffic near a hospital.

Data logging is a method of automatic data capture where a reading from a sensor is input at regular intervals. This data can then be processed to provide analysis of the environment (Fig 2.9).

Fig 2.9 This student is checking water quality using a sensor connected to a data logger. This data can then be processed to provide analysis of chemicals in the water

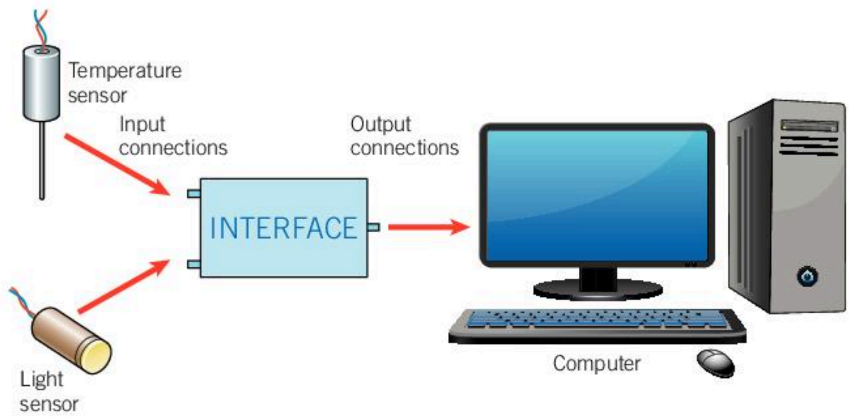


Fig 2.10 Components of a data logging system

A data logging system consists of sensors connected via an interface to a computer and some data logging software (Fig 2.10). The sensors will take measurements and at required intervals the software will record the data. The results can then be displayed as a graph or a table.

Microfilm

Microfilm is often used as an alternative to the printer. The output is 'printed' on a roll of film (computer output microfilm) or sheet of film (computer output microfiche) rather than paper. In addition to being faster, this method also condenses large stacks of paper into small amounts of microfilm or microfiche with no special programming. The drawback of computer output microfilm or microfiche (COM) is that it takes a special device to print the microfilm and a special viewer to read it.

Questions

1 State which of the following output is hard-copy output or soft-copy output:
- **a** human-readable
- **b** machine-readable.

2 Give an example of a document that is machine-readable.

File organisation and access relates to the use of records, fields and files.

- A **field** contains a single data item, and many fields comprise a record. Each field has a name and one is the key field used to identify the record.
- A **record** is a collection of related data fields (possibly of different data types) and treated as a single item for processing.
- A data file is a collection of records holding the same type of information but about different objects or individuals.

A file has three important characteristics:

1. It can be permanent or temporary.
2. The records of the file are specially organised on the secondary storage device. This is called file organisation.
3. Records are accessed (or located) using different methods.

Master and transaction files

Many businesses and organisations regularly access, modify and store large amounts of files. These files are given special names to identify their purpose. A master file is a permanent file which is kept up-to-date. It stores the main information, summary data and key fields in the data.

The master file contains two types of data:

- permanent data, such as employee personal data, payroll data employee status and job title
- temporary data, which is updated on a regular basis, such as hours worked and taxes deducted.

A **transaction file** is a temporary file which is used to update the master file after a certain time (at the end of each day or week, for example). The transaction file updates the master file. The records in the transaction file are used to perform three important operations:

- add: put a new record into the master file
- update: change the contents of a record or a field that already exists
- delete: remove a record from the master file.

Record matching

A **primary key** is normally used to identify the record you want to update or delete. It is a field in the record whose value is unique to that record. For instance, in a student record, the Student ID is normally used as the key field. Without a key field to identify the record you want you cannot delete or update records.

To delete or update records in a master file, compare the primary key in the transaction record with that in the master file record. If there is a match, you can update or delete the master file record. If both files are ordered (sorted) on the key field, then this record matching operation functions correctly, but if either the transaction or the master file is unordered, record matching cannot work.

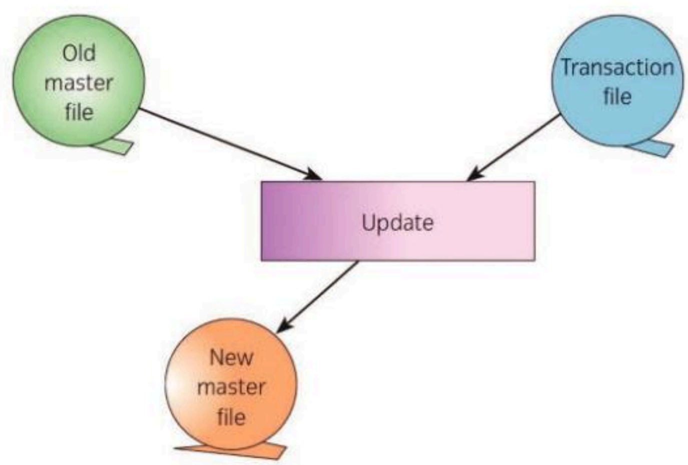


Fig 2.11 Updating a master file with a transaction file

There are three possibilities when updating a master file:

1. Transaction record key is *less than* the master file record key.
   The transaction record is added to the master file. Next transaction record is read.

2 Transaction record key is *equal to* the master file record key.
The master record is deleted or updated.
Next transaction record is read.

3 Transaction record key is *greater than* the master record key.
No more transactions for this master record.
Write master record to new master file.
Read next master file record.

Processing errors

Table 2.3 lists some errors or situations which can occur during processing.

Table 2.3 *Error messages during file processing*

Situation	Error
If the master file encounters an 'end of file' marker in the transaction file, then there is no data on which to update the master file	No data found
If you are searching for a record to update or delete in the master file, and it is not found	Record does not exist or invalid primary key in the transaction record. If you reach the end of the master file before the end of the transaction file, then either you are adding new records in the transaction file to the master file, or you are not updating the most current master file, or your master file may be corrupt
If you are searching for a location to add a record in the master file, and you find the record	Trying to add a record that already exists

Serial and sequential file organisation

Serial file organisation is the simplest type of file organisation. The records are arranged one after another, in the order in which they were added. That is, they have not been sorted into any particular order. Examples of serial files (also called unordered files) include unsorted invoices for customers for the day, and a typical shopping list. Serial files can be stored on tape, disk or in memory. A serial file is used mainly for backup purposes. Recording data in the order in which transactions are made is also useful if you need to restore transactions that have been lost from the master file through hardware or other problems.

Unordered file	Ordered file
Record M	Record A
Record H	Record B
Record B	Record G
Record N	Record H

A sequential file is one in which the records are stored in sorted order on one or more key fields. Examples of sequential files include invoices for customers sorted on customer number, and class registers sorted on last name. Magnetic tape is sequential by its very nature, just like listening to a cassette tape or watching a movie. To access a particular section or continue from where you left off, you must start at the beginning and scan forward until you reach the specific one.

Searching for a record

To search for a particular record, all the preceding records must be read. The main drawback to inserting, deleting or amending records in both serial and sequential files is that the entire file must be read and then the records written to a new file. Since disk access is slow, computer time is wasted even if only a few records are involved. For instance, if 10 records are to be added into a 1000-record file, then 1000 records will have to be read from the old master file and after the 10 insertions from the transaction file, 1010 records are written to the new master file. It therefore takes a long time to insert a new record with serial organisation. To maximise efficiency of processing, use sequential organisation, where the records are arranged in order by the value of the key field common to all records.

Summary of reading, writing and sorting for sequential files

Read access

- Records are read from the beginning of the file until the desired item is found
- If accessing a record, access time is increased to read the entire file or many records but decreased if few records are to be accessed

Write access

- Adding records to the end of the file is easy (may require sorting). However, it is difficult to add or delete data in the middle of the file.

Sorting

- Sequential files are often sorted on the record key to make processing simpler. However, sorting can be time consuming for large files.

Adding a record

For serial files, you simply add the new record to the end of the file. However, the major purpose of sequential files is to preserve the ordering of the file. This means that the record must be inserted into the file in the correct position and not at the end of the file as with serial files. Also, you cannot just insert all changes to records in sequential files into the existing file – you must create a new file that contains the inserted records.

The algorithm for adding a record is:

1. All the records with a key value less than the record to be inserted are read and then written to the new file.
2. The record to be inserted is written to the new file.
3. Finally, the remaining records are written to the new file.

Updating a record

Updates are normally done using magnetic tape in batch mode. All the updates are gathered together into a transaction file, and then applied to the master file together. Updating, therefore, is again accomplished by creating a new file which contains the updated records. Sorting the master file and transaction file records in the same order improves the efficiency of the updating process.

To amend a record in a sequential file:

1. All the records with a key value less than the record to be amended are read and then written to the new file.
2. The record to be updated is read, any changes are applied to it and the updated record is written to the new file.
3. Finally, all the remaining records are written to the new file.

Deleting a record

With both types of files, the only way to delete records is to create a new file which omits the records marked for deletion.

To delete a record in a serial file:

1. Compare each record with a key value of the record to be deleted (since the transaction file is not sorted).
2. If it is not the record to be deleted, then write that record to the new file.
3. When the record to be deleted is encountered it is not written to the new file.
4. Finally, all the remaining records are written to the new file.

To delete a record in a sequential file:

1. All the records with a key value less than the record to be deleted are written to the new file.
2. When the record to be deleted is encountered it is not written to the new file.
3. Finally, all the remaining records are written to the new file.

Direct access file organisation

A direct access file, also called a random access file, allows access to a particular record in the file using a key. This makes it much easier to find, read, delete, update and insert records. The file is organised like a one-dimensional table on disk where each record is a part of the table. The record number acts like a table index to allow you to find the records.

You can access a record directly or randomly by calculating its location using a mathematical formula and going directly to the record. For example, when you input an ID number, the mathematical formula uses it to produce a value that points to the storage location on disk where the record can be found.

Direct access files also support sequential access by allowing the records to be read one after another. The records in a direct access file are not sorted in ascending or descending order, but are stored in random order.

With hard disks, direct access is possible. With an audio compact disk, for example, you can play the songs in random order or go directly to the track you want to hear. However, not only must the medium allow for random access to records, but the file itself must be organised so that you can go directly to the record you want to retrieve. This can be compared to sequential organisation, as on a magnetic tape. You have to start at the beginning and run the tape forward until you get to the song you want to hear.

Summary of direct access file organisation

This organisation is best for:

- files which seldom change in size
- files which require frequent updates
- single record enquiries and updates
- processes which require fast access to records
- storage of master file records on direct access media only (such as hard disks)
- accessing disk file records sequentially or directly.

If processed directly, they need not be processed in order.

Index sequential file organisation

An **indexed file** is used to speed up the key search in a file. You can think of it as a one-column table organised in ascending order and stored on disk. The primary key in the table is used as an index to the record. It is just like the index of a book where the key value (topic) has a pointer to the storage location (page number) where the information is stored.

Many applications require a mix of sequential and direct processing of records. Consider a file containing customer accounts with three fields: 'Account Number', 'Credit limit' and 'Balance'. Every time a customer wants to make a purchase, his or her credit limit and balance must be checked; this requires individual access to his or her record. Every month, a statement must be produced for each customer; this requires sequential access to the whole file.

An index is a special file of records with two attributes: record key and the storage address of the corresponding record in the indexed file. A partial index containing the highest or the lowest key value in each block of records is useful when the index itself is organised sequentially. Ideally, you want to have the index in main memory. Then you can search the index quickly to obtain the storage address, and then retrieve the required record in a single disk access.

Searching for a record

The search key is compared with the index keys to find the highest index key that comes before the one you are searching for. Then a linear search is performed from there onward, until the search key is matched or until the record pointed to by the next index entry is reached.

For example, suppose you are in a supermarket where the items are stored on the shelves in alphabetical order (Fig 2.12). You wish to find forks. Instead of walking up and down each aisle, you look up at the listing (index) of what is in each aisle. This tells you which aisle to walk down to find the forks. You know to stop looking once you have found forks on the listing (Fig 2.13).

In spite of the double file access (index + data) needed by this kind of search, the decrease in access time with respect to a sequential file is significant.

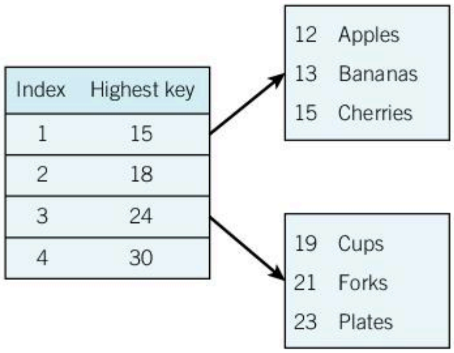


Fig 2.12 Index sequential file access

Fig 2.13 Supermarket aisle signs are similar to index sequential searches

Summary of index sequential access file organisation

- Instead of having an index entry for each record, have an entry for each block of records starting from the lowest or highest record.
- Leave spaces in each block to allow for easy insertions.

Table 2.4 summarises methods of access to a record for a variety of file structures.

Table 2.4 *Searching for a record can be achieved through various file organisations*

File structure name	Structure details	Access method
Serial file	Unordered records	Sequential access
Sequential file	Ordered records	Sequential access
Partially indexed file	Ordered records	Sequential access to index, followed by direct access to first record in the group, then sequential access to find the desired record
Fully indexed file	Unordered records	Sequential access to the index, followed by direct access to the data file
Direct access file	Unordered or ordered records	A calculation provides the address (location) of a record, followed by direct access to the record

Questions

1 Write the connection between a field, record and file.

2 Why are master and transaction files needed in most businesses?

3 What is the special name given to the field that normally identifies a record?

4 State the type of file organisation for each of the following descriptions:

- **a** records arranged one after another, in the order in which they were added
- **b** records stored in sorted order
- **c** records stored in random order
- **d** records stored with directory-type listings to denote location.

The processing of data into information occurs when a machine or processor acts on the input it receives. An example of this is an electric kettle which senses when the water temperature reaches boiling point and switches off. A car production line can sense when a car body is in a certain position and then act to weld together the relevant parts of a car. **Information processing** is only valuable if the information can be stored and retrieved quickly, accurately and efficiently and cannot be changed accidentally.

Setting up an information processing system

Before setting up an information processing system, a business should consider the following questions:

- Will computerisation really solve the particular problem?
- Is it cost-effective in the long term?
- How large is the amount of data to be handled?
- Is high processing speed really important?
- Can the present staff manage the system?
- Will the changes caused by computerisation lower the morale of staff?
- How can the loss of jobs be handled properly?
- What can be done to help staff adapt to computerisation?

Examples of information processing

Information processing can be done in almost all sectors of business. It is also becoming increasingly popular at home where bills can be paid either by phone or on the Internet. Other people use information processing for research and education through online classes where assignments and reports can be submitted electronically. In fact, anyone can use the Internet to find a wealth of information such as current affairs news, stock prices, educational materials, online banking and investments, shopping for goods and services, communication, and the exchange of information with other people around the world.

Table 2.5 *Advantages and disadvantages of information processing*

Advantages	Disadvantages
• Tasks can be completed faster because data and information can be processed at amazing speeds. • Computer storage devices can store enormous amounts of data and information for future use. • Automation can be introduced. That is, tasks can be completed with little human intervention. • Management can analyse new information and trends more quickly. • Data and information can be shared with other computers.	• It may need a high initial investment in equipment and training. • More money may be needed to employ specialised staff to operate and design the information processing system. • Some jobs may be lost as a result of computerisation, which may lower the morale of staff members. • Some staff must be trained or retrained. • Face-to-face interaction between staff may be reduced.

Health care

Information processing in health care may be used to:

- maintain patient records in hospitals and clinics
- monitor patients' vital signs in hospital, and at home
- perform computer-assisted medical tests
- research and diagnose medical conditions
- operate implanted devices such as pacemakers which allow patients to live longer
- control surgical instruments during operations that require great precision, for example laser eye surgery and heart surgery
- enable 'telemedicine' through computers with video conferencing capabilities
- train surgeons before they perform surgery.

Banking

Computers are used to keep track of all bank transactions. Customer accounts need to be updated every time a payment transaction is made whether by cheque, card or **EFT (electronic funds transfer)** at the point of sale (EFTPOS) is useful for customers in a shop. The bank card is inserted into a reader attached to the point of sale (POS) terminal. The payment is then made directly from the customer's bank account to that of the shop. The procedure is as follows:

1 The cost of all of the items to be purchased is added up, usually on a computerised cash register.
2 The customer presents his or her debit or credit card to the shop assistant.
3 The card is inserted so the chip can be read or swiped through a magnetic strip reader to input the card number and expiry date to a computer.
4 The card number, payment amount and identity of the company that has sold the goods are sent to the bank's computer using a modem and telephone line.
5 The customer types a four-digit **personal identification number (PIN)** on the keypad and presses the enter key to continue the process.
6 The bank's computer looks up the customer's account details in an accounts database.
7 If the card is valid and the customer has enough money in his or her account then the payment is approved.
8 The money is transferred electronically from the customer's bank account to the company's bank account.

Sometimes the magnetic strip reader cannot automatically read the card number from the card. If the magnetic strip has been damaged, then the sales assistant can enter the card number using a small keypad.

Payroll

A payroll system uses an information processing system to calculate the wages of each employee, print out pay-slips and record the information for accounting purposes.

Fig 2.14 Using a bank card in a reader attached to a point of sale terminal

Payroll example

Input: This may come from a database of employees' details, such as salaries, pay rates, bonus rates if employees are paid by the hour, then timesheets would be used to input and validate the number of hours worked and number of hours overtime, possibly using OMR or OCR techniques.

Processing: Using a software application such as a spreadsheet or more complex accounting software the computer then needs to calculate the gross amount earned by each employee, any bonuses, any deductions such as tax, national insurance, etc. and hence the net amount earned by each employee.

Output: The computer would need to print pay-slips. Use an impact printer if the pay-slip is required in duplicate for the employee's signature, or a non-impact printer otherwise. Update the employee database using a database integrated with the accounting software. Output details of payments to a banker's automated clearing service to pay money directly into employees' bank accounts using electronic commerce. Print summary reports.

Library

While travelling to a library to borrow books may be a regular activity for many students, libraries have been adjusting their collections, services and environments for the digital world. Most university libraries provide online access for their staff and students via an e-information portal. This allows users to search online databases for e-journals, e-books, and articles in the online, digital or e-library. In some cases, users can also search for and request a paper-based version of the article and then travel to collect it if it is available.

Library example

Input: After logging in to the online library, the user can search for an article in an online database by entering information such as a subject, the name of an author or the title of a journal or article.

Processing: The library's online databases would have files (tables) containing details about the books, magazines and journals in the library. The system uses the key terms entered to conduct the search.

Output: The e-library may show different options to view the texts. For example, if a book is available for online reading, then you may be able to download it as a PDF document or read it in your browser, with special e-reader software or a Kindle device. Some online content offers audio features for the visually impaired or is formatted to deliver book page images. Some online libraries also provide links to other e-libraries and may indicate if a hard copy is available.

Control systems

You are surrounded by computer control systems but probably do not know it. Here are some examples of control systems.

- Traffic lights are triggered by movement sensors or the vehicle interacting with the sensor embedded in the road (Fig 2.15). A traffic light control system would not be very useful or safe if it did not respond adequately to the oncoming vehicles and stop the traffic! To do this, there has to be a computer program which is constantly looking at the data from the sensors and making decisions about what the output device (the traffic lights) should do.
- In the kitchen, microwave ovens, washing machines and tumble dryers all have control systems inside them to make them do their job at the press of a button. In the sitting room, remote-control televisions, video recorders and audio systems have built-in control systems.
- All modern cars have a management system which tells the engine what to do. This can control the flow of fuel to the engine and stops the engine from going too fast. Remote-control locks respond to a signal from the key to operate the locks on the doors.
- Buildings with air conditioning have sensors which detect the temperature and humidity inside the buildings and turn the heating or air conditioning on or off when needed.

Fig 2.15 Control systems are around us all the time

In these examples many of the sensors have digital outputs. In the traffic lights example, the embedded sensor that detects an approaching vehicle needs only to know whether a vehicle is there or not. So an on/off digital sensor is adequate. A digital temperature sensor would only be able to tell the system that the environment is hot or cold. It would not be able to tell the system how hot or how cold it is.

The processing of information is usually integrated into a control system which has sensors to input information, a processing unit (computer) which decides how to respond to the inputs, and output devices which do what is required. A control system also needs an interface unit between the computer and the input sensors and the output devices. This unit turns the signals from the sensors into something that the computer can understand, and the signals from the computer into something that will work the output devices. The purpose of the interface is to make all parts of the system work with each other.

The processing unit in a control system may be a computer which has a program built into it. It will usually not be like the computers that you use, where you change the program by loading a new program from disk. The processing unit has a resident program in its electronic circuits. Such a system is called an **embedded controller**. Embedded controllers have only one program in their electronics to do the job they were designed to do. This makes them much cheaper to make because they do not need disk storage devices, a keyboard, a mouse or a screen. Once the system has been tested to make sure that it behaves as it should, these elements are not needed. The outputs will be the things that are being controlled, not a screen.

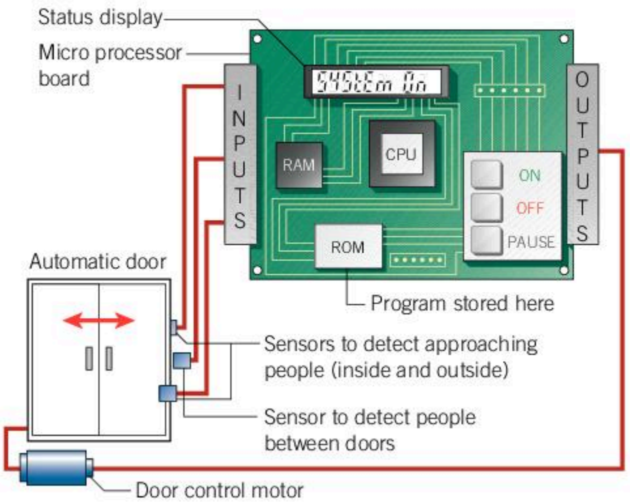


Fig 2.16 A typical control system looks like this. Note that it does not have a screen, disk or keyboard. The program is stored in ROM

Industry

Sometimes, in industry, a whole manufacturing process is controlled automatically by a computer system. Computer manufacturing systems do many tedious and repetitive tasks. In electronic circuit production, the components are automatically put in the right place on the circuit boards and then automatically soldered into position. The speed and accuracy at which these machines work are greater than those of skilled workers. The danger to the workers from the heat generated by soldering is removed by having automatic soldering systems.

The number of people needed in such areas of work has changed and usually been reduced. The skills the workers need have also changed. Rather than doing the repetitive tasks themselves, they now keep the machinery running and monitor activities.

Industry example

Input: Sensors take readings at regular time intervals and send the readings to the computer. Sensors may be measuring temperature, pressure, liquid flow rate and so on.

Processing: The computer analyses the readings and decides whether action needs to be taken.

Output: The computer sends output signals to devices which manage the process to increase pressure or temperature, for example. Some systems use an actuator, which is a device that reacts to a computer signal and operates a simple device such as a tap, motor or switch to regulate liquid flow.

Most of these systems use feedback, where the output affects the input.

Weather forecasting

Some of the world's most powerful computers are used to forecast the weather, which improves the accuracy of forecasts. People who rely on these forecasts include television companies, shipping companies, farmers, the military and outdoor sports organisations. Computer systems are also used to track hurricanes and tornados, monitor global warming, and monitor the ocean for systems of currents such as El Niño. Automatic data recording for weather forecasting has several advantages:

- It is more accurate than manual data collection.
- Computer data can be collected continuously whereas humans may get tired, and it can also be collected in situations not safe for humans.
- It is extremely fast. Computers can easily take thousands of measurements in a second. This means that events which could not be measured by a person can now be recorded for analysis later.

Table 2.6 *Sensors and their applications*

Sensor	Quantity measured	Application
Temperature sensor	How hot/cold it is	Monitoring the temperature in an oven
Light sensor	How light/dark it is	Turning street lights on when it is dark
pH sensor	The acidity of a liquid	Monitoring water pollution
Proximity sensor	Detects how close an object is to another object	Detecting how close a vehicle is when its driver is reversing near to a wall
Pressure pad	If a pad is being pressed	Detecting cars arriving at traffic lights
Button	If the button is being pressed	Obtaining a ticket to a paid car park
Light gate	Detects an object passing through the gate	Measuring the speed or acceleration of objects
Passive infrared (PIR)	Detects when a warm object moves into an area	Activating a burglar alarm if someone enters a room

Weather forecasting example

Input: Millions of pieces of data (observations such as temperature, pressure, humidity, infrared radiation) are collected from satellites, weather stations, weather balloons, aircraft, radar, weather ships and automatic weather buoys. All these readings are sent to the respective meteorological office's computer systems.

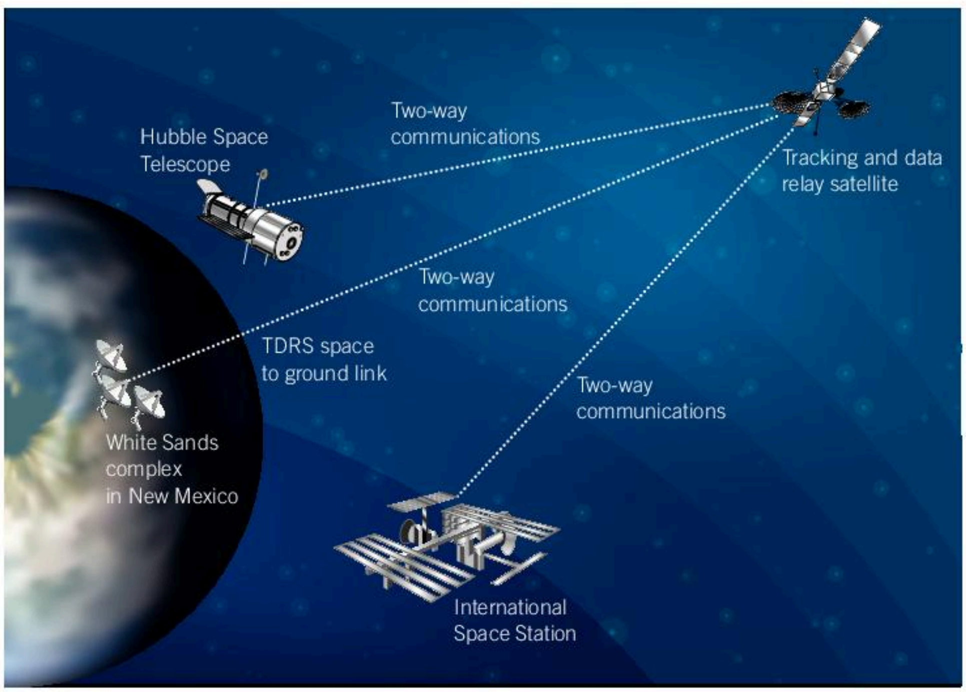


Fig 2.17 Data is collected from satellites orbiting the earth

Processing: The data is stored in a large database. The first task is to perform a quality control check on the data (validation) and to reject all invalid readings.

The data is formatted to fit in with a numerical model of readings. From this computer model, forecasts can be made. The bulk of processing is 'number-crunching' and solving thousands of inter-related equations.

Output: The forecasts are normally produced as global and local charts of weather information.

Supermarket stock control

Most businesses need to hold stocks of goods. Shops need to hold stocks of goods they sell, and manufacturers need to hold stocks of raw materials and finished goods they make. The task of recording and maintaining stock levels is called stock control.

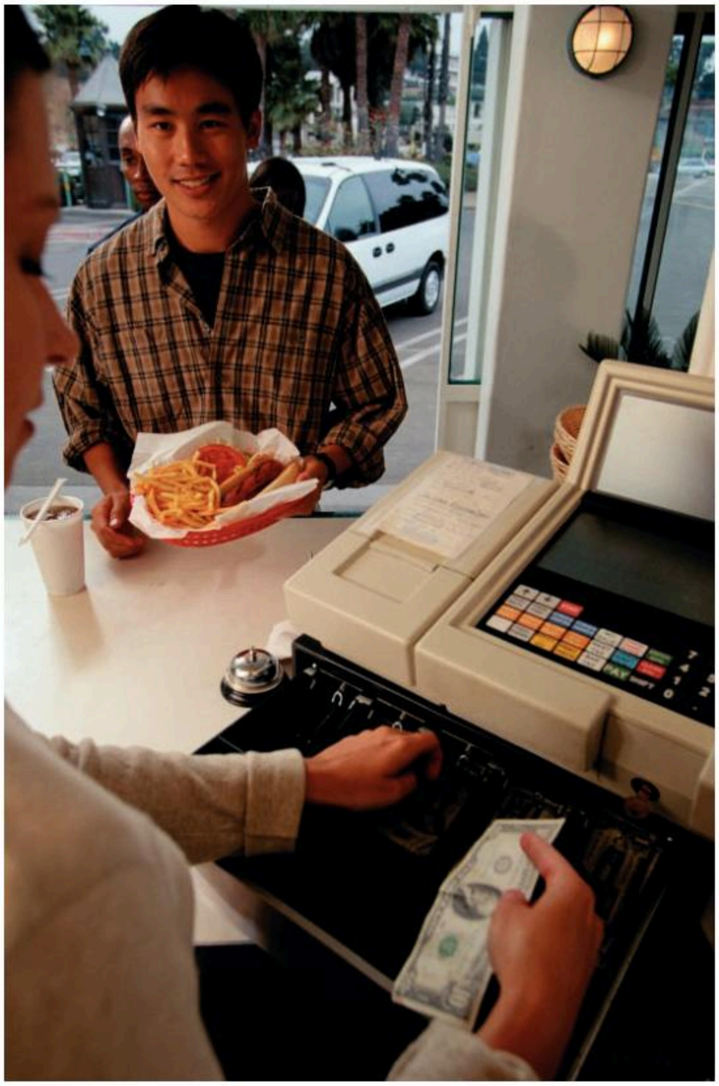


Fig 2.18 A point of sale terminal

A stock control system must keep an up-to-date record of all the stock held and place orders for fresh deliveries if stock runs low. Large shops, supermarkets and factories use computerised stock control systems.

Stock control is important as:

- Adequate stocks must be maintained to supply a customer with goods with minimum delay. If customers find goods are regularly out of stock they will go elsewhere.
- Goods must not be overstocked. By keeping stocks to a minimum, a business can limit the amount of money invested in stock and also reduce the risk of stock deteriorating before it can be sold. Minimum stock levels also reduce storage costs such as warehousing, heating, lighting and security.

A real-time stock control system

Input: The operator at a POS terminal only needs to pass the barcode on each item past a laser scanner. The scanner reads the code number stored in the barcode and sends it directly to a computer. The computer checks the code and, if it is valid, looks up the product's name and price in data files held on disk. The name and price are sent back to the POS terminal.

In this way the POS terminal can print out an itemised receipt. Note that with POS systems, prices are usually only marked on shelves and not on individual items, which can cause customer confusion. Each terminal has a keypad or keyboard that can be used if a barcode cannot be read.

Processing: As each item is sold, the stock files are updated so that customer service can be much quicker, reducing queues. Few mistakes can be made in charging customers. Prices can be changed easily. A fully itemised bill can be provided for the customer. No staff are needed for counting stock on shelves.

Output: Orders are printed when stock levels reach a re-order point. Customer receipts are printed using thermal printers.

Questions

1. Give an example of the processing required to determine if a customer's bill is overdue.
2. Give three examples of data that sensors can be used to measure.

Multiple choice questions

1 The manipulation of data to obtain information is called:

a input
b output
c processing
d storage.

2 Information that represents a 'whole' picture of a problem or solution is:

a accurate
b complete
c relevant
d timely.

3 A __________ check compares the contents of two or more fields to make sure that they make sense.

a consistency
b range
c data type
d format.

4 Hardware errors can be caused by any of the following, *except*:

a bad sectors on a hard disk
b corrupt RAM
c power surge
d program malfunction.

5 Which of the following checks is used to detect doubtful data?

a length
b range
c data type
d reasonableness.

6 An area code must contain three digits only. The following checks are suitable, *except*:

a data type
b format
c length
d range.

7 A __________ file is a temporary file which is used to __________data in the main file.

i transaction, delete
ii transaction, update
iii master, delete
iv master, update.

8 To find a record in a file using a sequential search, repeatedly __________ a record until the required record is found.

a read
b save
c write
d update.

9 A fully indexed file contains the record key and the storage address of the:

a average key value
b exact key value
c highest key value
d lowest key value.

10 The access method that calculates the exact address (location) of a record is *most* suitable for which type of file structure?

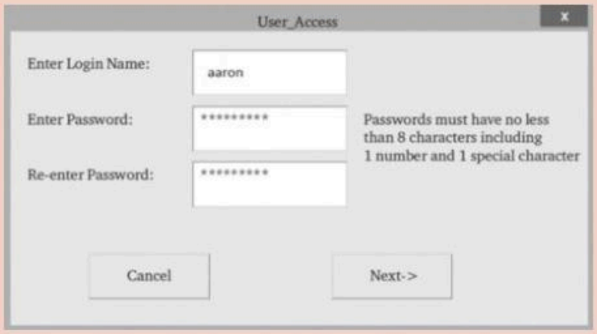
a serial
b sequential
c fully indexed
d direct access.

Short answer questions

11 A data logging system is used to record, at specific intervals, the temperature of the water in an aquarium.

a State one item of hardware that can be used to capture the temperature readings.
b Explain what the logging system could output if the temperature of the water is too high.
c Describe one advantage of monitoring the water using this data logging system.

12 Aaron uses a login screen as shown below:



- **a** Give two types of applications that would require a user to log on.
- **b** Describe two security measures used on the screen displayed.
- **c** Explain why the password must be entered twice.
- **d** Explain whether re-entering the password twice is an example of verification or validation.
- **e** Explain two messages that the system could show based on the information entered by the user.
- **f** After Aaron has entered his username and password, he needs to press one of the two buttons on the screen to continue. What type of screen is Aaron using?

13 A student enters the following data from an experiment on a sheet that contains the headings and instructions on what to enter:

Results sheet

Experiment number	**Start temperature**	**End temperature**	**Temperature difference**
1	40	50	110
b	50	65	15
3	52	68	Yes

- **a** Three errors were made in the results sheet. Explain these errors.
- **b** Explain each of the following checks as it relates to the results sheet above:
  - **i** data type check
  - **ii** range check.
- **c** Describe how the student could confirm that the data from the table is equivalent to the data on the sheet.
- **d** The four statements below show the different descriptions during the experiment when completing the sheet. Match each of the descriptions with the most suitable term from the list below:

  Terms: source document/turnaround document/machine-readable document/soft copy/hard copy

  Statements:
  - **i** The blank sheet before the student writes in results from the experiment.
  - **ii** The sheet is scanned and saved as a PDF file.
  - **iii** Results from the data on the sheet are used to produce a set of charts which are viewed on a monitor.
  - **iv** The completed sheet and charts are printed.
- **e** A teacher needs to print 70 copies of the sheet for the next class.
  - **i** Explain which type of printer would be suitable for this task.
  - **ii** No pages are being printed, even if the teacher selects the print icon repeatedly. Explain two possible causes of this problem.

14 Consider the following illustration of a supermarket, where items are placed in aisles:

Aisle	**Locator**	**Item #**
1	35	25 – Carrots
		27 – Cucumber
		29 – Lettuce
		32 – Sweet pepper
2	50	38 – Disinfectant
		40 – Liquid soap
		43 – Scrub buds
		47 – Sponges

- **a** State the path taken to locate the:
  - **i** lettuce
  - **ii** sponges.
- **b** Suppose you were looking for item #30 (ginger).
  - **i** State the aisle and locator that you would choose and the item # that would indicate whether it is there or not.
  - **ii** What does the number of the locator represent?
- **c** Explain whether this is an example of direct, sequential or index-sequential file organisation.

CHAPTER 3

COMPUTER NETWORKS AND WEB TECHNOLOGIES

3.1 Computer networks

Previous chapters have covered the fundamentals of a single computer system and its peripherals. Now we will look at linking computers together to enhance communication among users, whether in the same office or across the world.

Data communication is the transmission of data and information between two or more computers. Many computer users need to be able to connect their computer to other computers, whether located close by or at a remote site. For example, office workers may want to communicate with data on computers at their workplaces from wherever they may be working in the world, and home computer users may want to access the Internet. Data communication is essential for electronic mail (email), voicemail, facsimile (fax), telecommuting, video conferencing, electronic data interchange (EDI), global positioning systems (GPS), online services, social media and the Internet.

Many schools, businesses and other organisations link computers together to form a network so that they can transmit data and information to share files, resources such as disk drives, CD-ROM drives, modems or printers and programs such as word processors, spreadsheets and databases. There are two ways that data can be transmitted between computers:

- to **upload** data means to send this data from your computer to another computer on the network or the Internet
- to **download** data means to receive data to your computer from another computer on the network or the Internet.

Computers can be linked in different ways, or configurations, to transmit data. Two configurations are:

- **point-to-point:** a direct link between two computers in a network
- **broadcast:** using one computer to transmit data and information to serve the needs of several terminals or computers connected to it in a network.

A popular way of transmitting data is through microwaves, which are high-frequency radio signals that travel through the atmosphere. They are used for high-volume, long-distance communication. Microwave signals, however, only travel in straight lines. They can be bounced off satellites to cover longer distances. Low-orbit satellites travel closer to earth, so weaker signals can be processed while consuming less power. An example of a system that uses microwaves is a cellular network that supports two-way communication. These networks use interconnected cell sites that communicate with mobile (or cellular) phones.

Network configurations

A computer network connects computers so that peripherals such as printers can be shared among computers. Networks come in different sizes. A few computers, printers and large hard disks – usually on one site – can be linked in a small local area network (LAN). Many small and large computers, located on different sites spread over a large geographical area or in different countries, can be linked in a wide area network (WAN). A good example of a wide area network is the Internet.

A Metropolitan Area Network (MAN) falls between a WAN and LAN. It is large enough to extend to an area like a city or campus. A MAN might therefore be owned and operated by a single organisation (for instance, a university) and accessed by students and other associated organisations. MANs are useful in connecting LANs to WANs like the Internet.

Computers that are not networked are known as **stand-alone** computers. Data that is on a stand-alone system has to be transferred using a secondary storage device if it is to be used on another computer.

Not all networks are connected with cabling; some networks are **wireless networks**. A Wireless Local Area Network (WLAN) is a LAN that is great for allowing laptops or remote computers to connect to the LAN. Wireless networks are also beneficial in older buildings where it may be difficult or impossible to install cables. However, they provide poor security and are susceptible to interference from light and electronic devices. They are also slower than LANs even when connected using cabling.

To connect a computer to a LAN using cables, you plug the network cable into the network adapter on the computer. You then have to set up the system software which enables the computer to operate on the network. The computer is now ready to share files, resources and programs with other computers/users.

To connect computers to a LAN using cables, you need:

- network cabling
- a network card in each computer
- a hub (or hubs)
- a file server
- system software.

Hubs

If you have a network in school, it is likely that the computers are connected by cable to a central device called a **hub** (Fig 3.1). One or more hubs (if there are a large number of computers on the network) are then connected to a file server. A **file server** is a high-performance computer containing large capacity hard disk drives that are available to all network users. It is where application programs and data can be shared to all users on the network. A file server is not used as a normal computer terminal, as its job is dedicated only to the task of managing shared files. Some networks also use a printer server that is dedicated to managing all printers on a network. Where one powerful computer controls others, the network is called a hierarchical network.

Fig 3.1 Layout of a typical computer network

Peer-to-peer network

When a network does not have a file server, it is called a **peer-to-peer network**. In a peer-to-peer network, each computer acts as a server to the other computers – its peers – on the network. A peer-to-peer network also allows users to access each other's hard disks and peripherals.

Network layout

Careful planning of a computer network is essential. There are three main types of layout (topology) of computer networks: star, bus and ring.

In a **star network** (Fig 3.2) all the nodes are connected to a central hub. This means that each computer has its own connection to the network and that a break in a cable will not affect the working of other computers. If the hub breaks down, then all the computers on the hub will not work. However, star networks, although more expensive to install than other types, are the quickest.

Fig 3.2 A star network

A **bus network** is the simplest type of topology, where the network nodes (computers) are in a line, as shown in Figure 3.3. Bus networks are cheap and reliable, but if the cable breaks the network is split into two unconnected parts. Bus networks are slower than star networks, with the speed of network traffic limited to 10 Mb per second.

Fig 3.3 A bus network

Unlike a bus network, a **ring network** (Fig 3.4) has no end to the line. The last node (computer) is connected to the first node, forming a ring or loop. As with a bus network, if the cable breaks it will affect all the computers on the network. Ring networks are also slower than star networks, with the speed of network traffic limited to 10 Mb per second.

Fig 3.4 A ring network

The Internet is a vast collection of computer networks spread throughout the world, which involves all these different ways of linking computers. The most common way to link computers on a network is by cables such as fibre optics or telephone lines. Wireless networks however, are linked by infrared waves, microwaves or radio waves.

WLANs use high frequency radio signals, infrared light beams, or lasers to communicate between the workstations and the file server or hubs. Each workstation and file server on a wireless network has some sort of transceiver or antenna to send and receive the data. Data is relayed between transceivers as if they were physically connected. For longer distances, wireless communication can also take place through mobile telephone technology, microwave transmission or by satellite.

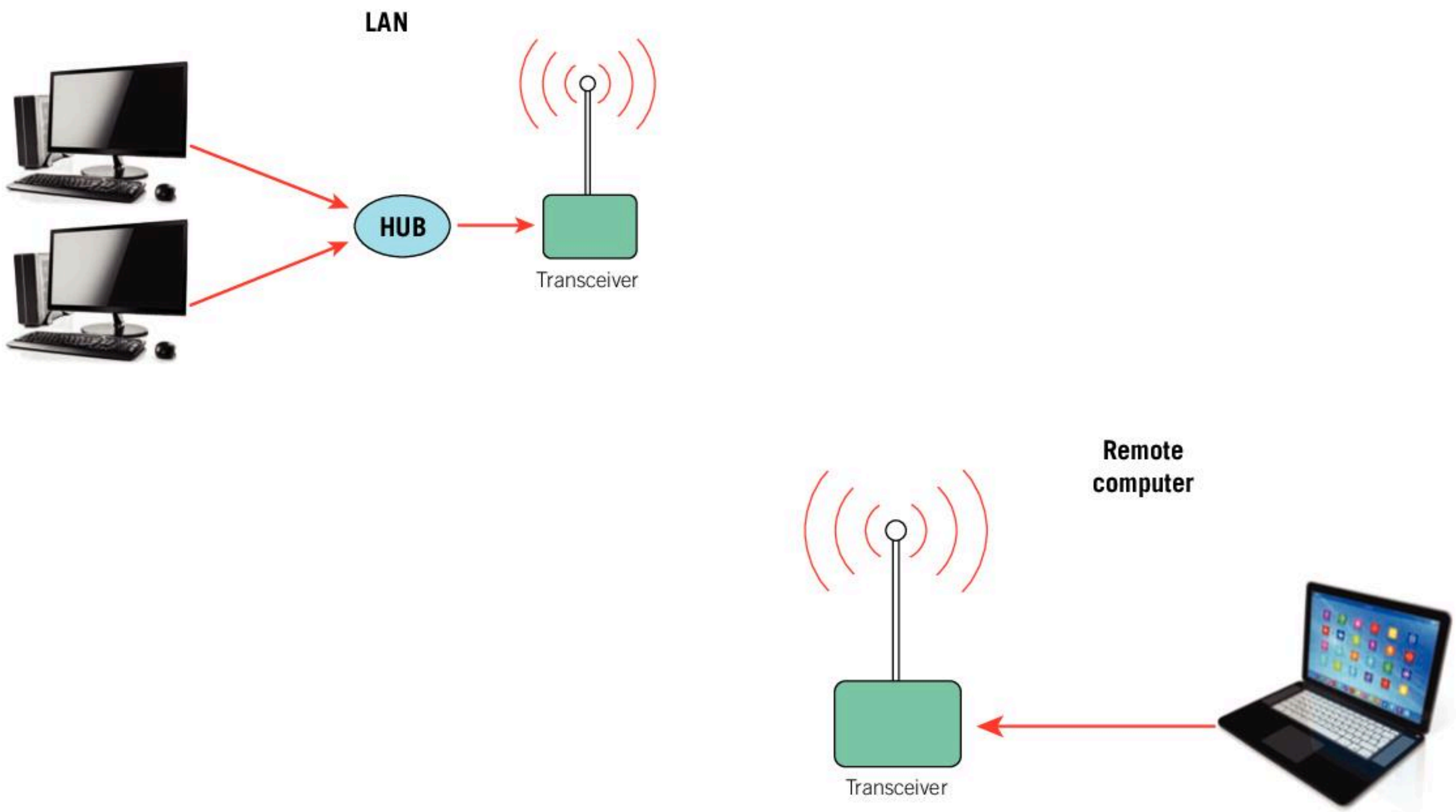


Fig 3.5 Remote computers can connect to the LAN through the transceivers as if they were physically connected. Transceivers are often built into hubs, laptops and portable devices

Bluetooth and **Wi-Fi** (short for wireless fidelity) both provide wireless connectivity using radio waves. The main purpose of Bluetooth is to replace cables, while Wi-Fi provides high-speed wireless access to a network or the Internet. Bluetooth allows for the exchange of data over short distances among wired and wireless devices. WLANs provides easy access to information between wireless devices from different manufacturers. Devices with Wi-Fi, such as computers, mobile phones, games consoles or MP3 players, can connect to the Internet if a wireless network is with a certain range.

A **hotspot** is a public area as small as a room or as large as many square miles that offers Internet access over a WLAN. Wi-Fi hotspots can be in cafés, airports and hotels. Wi-Fi connections can be made up to about 300 feet away from a hotspot, to keep users connected wirelessly while commuting. Customers may have to pay for this service.

Table 3.1 *Advantages and disadvantages of networked systems compared with stand-alone systems*

Type of system	Advantages	Disadvantages
Stand-alone computers	• Ideal for most home users • No network card needed • Can be dedicated to a specific task, e.g. composing music • No need for network software licences – only single-user licence required • Security from users on other sites	• Cannot easily share data, particularly large amounts of data, with others • Data can be transferred only by disk or by modem. Will need to use an external hard drive or online storage, which can be time consuming and unreliable
Networked computers	• Access to network from any workstation • Share files with, and send messages to, other computers • Share resources such as disk drives, CD-ROM drives, modems or printers • Share programs (such as word-processing, spreadsheet or database software) which are stored centrally. Possible for network users to work on the same file rather than each user having their own file. These programs are cheaper per user than one-off software for stand-alone computers • Activities of network users and such things as amount of storage space available to users can be controlled by network manager	• Network cards, cabling, hubs and servers can be costly. Wireless connection to a network may result in reduced data transfer rates and unreliable connectivity • If the file server stops working (known as a 'crash'), it can stop everybody on the network from using a computer • Poor security. With more users there is a greater risk of computer viruses and of unauthorised users (hackers) gaining access to network data • Need for network manager to manage the system. This can be costly

Communication channels

The **communication channel** is the method or medium used for transmitting data. Characteristics of communications channels include transmission mode, direction of data flow, transmission medium and transmission speed.

Transmission modes

Transmission modes or rates determine the number of characters that can be transmitted in one second. Two modes are:

- **asynchronous:** data is transmitted at irregular intervals, and at a low speed of one character at a time
- **synchronous:** data is transmitted at regular intervals, with high-speed simultaneous transmission of large blocks of data.

Direction of data flow

Transmission lines and media can also be classified according to the direction in which data can flow.

Simplex

Data in a **simplex** line can flow in only one direction, just like traffic in a one-way street. It is a send-only or receive-only line. Examples are radio, TV, computer to printers, public address systems or any other one-directional transmission.

Half duplex

Data in a **half-duplex** line can flow in both directions, but only one way at a time. In other words, data can be either sent or received at any given time. CB radio and walkie-talkies are half-duplex.

Full duplex

Data in a **full-duplex** line can be both sent and received at the same time, like traffic in a two-way street. Most modem connections today transmit full duplex. This increases efficiency, as data flows on the same pair of wires in both directions simultaneously.

To choose which channel to use, you should first decide how much information you want to transfer at any given time, how important it is to have a fast or slow transmission rate, as well as whether you want a full-duplex, half-duplex or simplex channel.

Transmission media

Data can be transmitted through various types of cabled (wired) or wireless media. Cabled media uses wires to transmit data. Wireless media transmits data through the air. Cabled media include twisted pair, coaxial and fibre optic cables; wireless media include satellite, microwave and infrared methods.

Cabled media

Cabled media include twisted pair, coaxial and fibre optic cables.

Twisted pair or ethernet cable

A **voiceband** channel can transmit data at a rate of 300 bits per second (bps) to 9600 bps. The most popular form of transmitting data is via telephone lines. This is easy to handle and cheap, but relatively slow. You need a modem to do this, since telephone lines are built to handle analogue data and not the digital data found in computers. Twisted pair wires are used for this form of data transmission.

Unshielded twisted pair (UTP) is common in telephone cables (Fig 3.6). These cables have pairs of insulated copper wires twisted round each other to help eliminate interference from adjacent pairs and other electrical devices.

An **ethernet cable** (Fig 3.7) is one of the most popular forms of network cable. It resembles a phone cable but is slightly larger. These cables have different colours which differentiate them from phone cables which are usually grey in colour. Like any cable, an ethernet cable has various lengths, but the longer the cable, the weaker the strength of the signal.

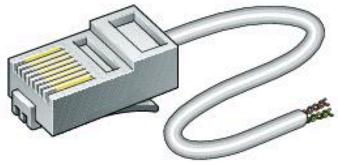


Fig 3.6 Twisted pair cable is used with telephones

Fig 3.7 Ethernet cables are used as network cables

Coaxial cable

A **broadband** channel can transmit data at a rate of thousands of characters per second. Examples of broadband channels are coaxial cables and fibre optic cables.

Coaxial cables (Fig 3.8) are found on televisions, videos and cable TV. They use thickly insulated copper wire and are capable of high-speed transmission but are difficult to install since the cable is somewhat rigid.

Fig 3.8 Coaxial cable is used for televisions, video and cable TV

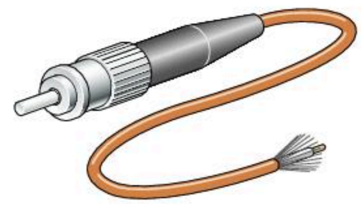


Fig 3.9 Fibre optic cable is used by large telecommunication companies

Fibre optic cable

Fibre optic cables (Fig 3.9) are similar to those used by large telephone and telecommunications companies. These cables consist of clear glass fibres and data is transmitted through them as pulses of light rather than electronic signals. This eliminates the problem of electrical interference. It is the standard for connecting networks between buildings, as it is also not affected by moisture and lightning. Fibre optic cables can transmit signals over much longer distances than coaxial and twisted pair cables. They can also transfer information at vastly greater speeds. This makes it possible to use broadband for services such as video conferencing and interactive services.

Wireless transmission

Remember that wireless media include microwave, satellite and infrared methods. A microwave signal has a very short wavelength, hence the word 'micro'-wave. These powerful signals can be projected over long distances over a direct line-of-sight path between any two points, such as antennae. Satellite transmission is similar to microwave transmission. However, instead of using two microwave dish antennae that are close to each other, it uses a satellite that is located in space.

Fig 3.10 Dish antennae point to satellites located in space

The two most common types of infrared communications used in schools are line-of-sight and scattered broadcast. Line-of-sight communication means that there must be an unblocked direct line between the workstation and the transceiver. If a person walks within the line-of-sight while there is a transmission, the information would need to be sent again. This kind of obstruction can slow down the wireless network.

Scattered infrared communication is a broadcast of infrared transmissions sent out in multiple directions that bounces off walls and ceilings until it eventually hits the receiver.

Intranets and extranets

The success of the Internet has led businesses and other organisations to set up intranets. Many schools now have their own intranet.

Intranet

An **intranet** is a private network based on Internet standards but only available within a business or other organisation. No one outside the business or organisation is able to access the intranet. A company can set up an intranet and allow its workers to send messages to each other and use a browser to access company information saved as web pages. It can also be used for staff training. An intranet is not directly connected to the Internet, but some intranets do allow access to the Internet, via so-called gateway computers. For users of an intranet, it looks and functions just like a website.

Intranets may, depending on how they are set up, consist of local area networks (LANs) and wide area networks (WANs). A firewall is used to stop computers on other networks, including the Internet, accessing an intranet. Instead, all communication is through a proxy server that is outside the network. The proxy server acts as a gatekeeper, filtering Internet sites and deciding what files or messages should come in to, or go out from, a computer network.

Intranets are used by many businesses and other organisations to:

- distribute documents
- share information
- distribute software
- access databases
- help with staff training
- facilitate group work
- enable teleconferencing.

Intranets are popular as they are less expensive to build and manage than other types of private network. Also, users of intranets are familiar with how to use them because they look and behave like websites on the Internet. This saves time and money on staff training.

More and more schools are setting up their own intranets. Internal school information, such as examination timetables, room changes, sports teams and results, can be readily shared with staff and students. Each department in the school can have its own intranet page(s) along with relevant information for students, such as revision guides and homework tasks. Students also have the opportunity to share their work with others.

Extranets

Once intranets were developed, it became clear that businesses and other organisations sometimes wanted to allow others, such as suppliers and customers, to have limited access to their intranet. This would lead to a closer relationship with customers, a better exchange of information and improved efficiency. Therefore, **extranets** were developed. Extranets allow authorised outsiders limited access to an intranet. Not everyone is allowed access to an extranet. Only authorised users are allowed. They must have valid usernames and passwords and an identity that establishes which part of the extranet they can access.

Extranets enable businesses to work closely together. A car manufacturer, for example, might develop an extranet to allow all of its various suppliers (of tyres, lights, windscreens, seats and so on) and car showrooms to keep in very close contact regarding orders and deliveries. An extranet could be used to share information not available to the public, as well as to exchange data and to develop joint training programmes. Data can be exchanged using electronic data interchange (EDI). Electronic data interchange is a special way to transfer business documents, such as orders and invoices, between computers.

The aim of EDI is to speed up communication between businesses and other organisations, and eventually to do away with paper transactions. EDI often involves putting the data into special computer code to stop other people looking at the data.

Questions

1 State the term that describes each of the following:
   - **a** data that is sent from a user's computer to another computer in the network
   - **b** data that is received to a user's computer from another computer in the network.

2 Give two examples of using microwave signals.

3 Name two peripheral devices that are usually connected to a network.

4 Explain what the following terms represent:
   - **a** WAN
   - **b** LAN
   - **c** WLAN
   - **d** MAN.

5 What is the name of a network that does not have a file server?

6 Name three arrangements of a network.

7 What is the term given to an area that offers Internet access over a WLAN?

8 State the type of transmission for each of the following descriptions:
   - **a** data can flow in only one direction
   - **b** data can flow in both directions, but only one direction at a time
   - **c** data can be sent and received at the same time.

9 State the type of transmission media that describes each of the following:
   - **a** uses wires to transmit data
   - **b** transmits data through the air.

10 What is the name given to a network that is private to a business?

The Internet has been described as 'a network of networks', connecting billions of mobile devices, laptops, microcomputers, minicomputers, mainframes and supercomputers linked in commercial, government and educational networks.

Today businesses set up websites on the Internet so that:

- they can advertise what they do and what they sell
- people can email enquiries, orders and requests
- they can reach an international audience.

The main services provided by the Internet include:

- **Electronic mail (email)**: This a method of communication between computers on a network. Email means messages that can be sent 'electronically' using special software from one computer to another anywhere in the world, via networks such as LANs and WLANs. The mail is then kept in an electronic mailbox. Examples of email software include Microsoft Outlook and Gmail.
- Data exchange: Sending data to another computer (uploading) or receiving data from a computer (downloading).
- Instant messaging: This feature allows users who are connected to the Internet at the same time to exchange text, images, video or audio messages in real time. Different providers have their own brand names for this service, for example Facebook Messenger and WhatsApp.
- The World Wide Web (www): Popularly known as the web. This is the main way of accessing information on the Internet. The web is based on pages of information which are linked and viewed by a web browser. By clicking with the mouse on a link (links are usually underlined words displayed in different colours), you can jump to another location on the web page, or to another web page or website. Millions of web pages are available on virtually every topic imaginable.
- File transfer protocol (FTP): A protocol is a set of rules and procedures that govern transmission between components in a network. Each network has a set standard for transmitting information, so that computer A in Germany can understand information coming from computer B in Barbados or computer C in France. FTP is the name given to the transfer of files across the Internet. FTP is the Internet equivalent of a file server, with files made available on thousands of the Internet's computers for downloading onto individual computers. Millions of users use FTP to download updates to popular software, such as Microsoft Word and Excel, although it can also be used to upload (send) files to websites.

Connecting to the Internet

Computers can be connected to the Internet in different ways. Once connected, users are said to be online. To access the Internet, you need:

- a modem, router and/or switch which is connected to a telephone line
- a network interface card (NIC) or network adapter, which is usually already installed in your computer
- software on your computer or mobile device (such as a web browser and email package)
- Internet service, which is typically a subscription with a company called an Internet service provider (ISP).

A modem (modulator/demodulator) is provided by your ISP, who provides you with access to the Internet. The purpose of the modem is to convert analogue and digital signals between your landline and the Internet. ISPs in the Caribbean include Digicel and Flow. If you are using more than one computer with a modem, then you will need a **router** in addition to the modem.

A router is the 'traffic cop' of a network. It directs data from the modem and sends it to the different devices that are connected to it. Devices such as computers, laptops, games consoles, digital televisions and mobile devices can be connected through cables directly to the router or wirelessly.

A switch simply expands the number of devices that can be connected to a router. Some routers, such as Netgear models, combine the three networking components – modem, router and switch – instead of having separate devices with cables joining them.

A network interface card (NIC) or network adaptor is hardware that is usually already part of a computer or laptop. It provides the computer with a dedicated connection to a network. These cards can be used for wired or wireless connections to the network.

Web browsers and email

The World Wide Web (www) is based on millions of pages of information linked together and viewed by Internet browsers also called web browsers. A web browser is a software application that allows you to access resources and websites on the Internet. Popular browsers include Microsoft Edge, Firefox, Google Chrome and Internet Explorer.

Internet service

There are different types of Internet services, including dial-up, DSL (broadband or cable), and wireless (3G or 4G) for mobile devices.

- **Dial-up:** This form of connection is the slowest way to connect to the Internet. You need to use your landline telephone to connect to the Internet via dial-up. This means that you cannot use the phone while online.
- **Broadband:** This method uses a digital subscriber line (DSL) service, which is faster than dial-up. It uses a phone line to connect to the Internet but it is not necessary to have a landline to make the online connection. However, if you do have a landline, broadband allows you to use the phone while connected to the Internet.
- **Cable:** Many cable television customers can connect to the Internet using a cable modem which sends and receives digital data through a connection to a fibre optic cable television system. Cable television such as Direct TV is a broadband service – a single cable can carry several channels at once – which results in unlimited data being sent and received at very high speeds. Users can also access the Internet at home on a digital television set rather than a computer.
- **2G, 3G and 4G-LTE:** These services are mostly associated with mobile phones since they are used to connect to the Internet through your provider. However, these connections are slower than broadband and cable. The amount of data sent and received is restricted by your provider, who can charge monthly rates for the data that is used. However, there are companies and universities that offer free Wi-Fi for users who are within the vicinity, to avoid using up personal data allowances.

The 'G' refers to the generations of mobile phone systems. Table 3.3 compares the generations.

Table 3.2 *Methods of connecting to the Internet*

Dial-up	Requires a landline and a modem to connect to the ISP. A point-to-point connection is established to connect to the Internet.
DSL	High speed Asymmetric Digital Subscriber Line (ADSL) that is used with a DSL modem to connect to the Internet. Users can connect to the Internet while using the landline. However, more data can be received from the Internet than is sent.
ISDN	Similar to an ordinary telephone line. The amount you pay depends upon how much you use the line. ISDN is more expensive to use than an ordinary telephone line, but can transmit data digitally at 64 kbps. ISDN lines can be grouped together in pairs to provide even faster data transmission.
Leased line	For a fixed fee per month, a company can rent this dedicated communications line to send and receive large amounts of data. The amount that is charged does not depend on how often the line is used. Speed of a leased line does not change, for example a T1 line has a speed of 1.5 megabits per second.
Cable TV	Uses a cable TV to connect to the Internet. It has fast download speeds, but slower upload speeds
Satellite	Connects to the Internet by using a satellite, an antenna, a coaxial cable and Windows-based software
Wireless	A wireless Internet connection or Wireless Application Protocol (WAP) can be used to connect devices like laptops, mobile phones, remote controls, gaming controls and tablets wirelessly without a physical connection.

Table 3.3 *Comparison of 2G, 3G and 4G-LTE*

Generation	Features	Problems	Example
2G	Text messaging, multimedia messaging, Internet access, caller ID and the SIM card	Phone calls dropping and slow data transmission rates	
3G	All of 2G, plus web browsing, email, video downloading, picture sharing and other smartphone technology	Major limitation of the 3G network is network coverage	
4G-LTE	All of 3G plus significantly faster speeds and increased network coverage	Still problems with network coverage	

Web technology concepts

In order to access the services on the Internet, the following terms will help you to become familiar with some web technology concepts.

Internet protocol

With so many different computer networks linked together on the Internet, there has to be a standard way in which different networks are linked together. The set of rules, sometimes known as a protocol, for sending and receiving data over the Internet is known as TCP/IP (transmission control protocol/Internet protocol). TCP/IP breaks down the data into little chunks, or packets, which are sent to other computers on the Internet. TCP/IP then ensures that the data is reassembled into its original form.

Getting data sent to the right computer on the Internet is very important, particularly when there are so many. When you address a letter to be sent through the post, you have to be specific about where you want it to go, providing a house number and postcode, or a PO box number. The same principles have to be applied when using the Internet.

A host (server) computer on the Internet is one that provides services such as email, news or data to other computers. Each host computer has its own unique address to identify it. This address is known as an IP address (Internet Protocol address). The IP address is usually four numbers separated by full stops: for example, 194.238.196.100. The first two or three numbers identify the computer network, with the rest identifying the individual computer.

It is much easier to type in and remember a domain name, such as www.cxc.org, than having to remember the IP address. But as far as the computer is concerned, the IP address is crucial. Every time you send an email, or browse a web page, your IP address is sent behind the scenes. This way your Internet usage can be tracked!

Internet address

Every site on the Internet has an address known as a URL (uniform resource locator). To access a site, you enter its address (URL) into the web **browser**. There is a space at the top of the screen (labelled 'address') for you to enter the URL. For example, typing www.nationnews.com would give you access to the *Nation* newspaper for up-to-date news and links to other Caribbean newspapers.

Table 3.4 *Understanding Internet addresses*

//	A double slash (//) in an address gives you the path to the computer (server) on which the resources are stored
/	A slash (/) in an address shows the path (route) to where resources are stored on the server. In other words, the exact location
http	This tells you that it is a website. Http (hypertext transfer) is the set of rules (protocols) used to show web pages on a computer that have been retrieved from web servers
ftp	File transfer protocol. Ftp sites are not websites, but sites that allow you to transfer files across the Internet
.com	.com in an address indicates a commercial organisation: for example, www.nationnews.com
.uk	.uk in an address indicates that the country is the United Kingdom: for example, www.bbc.co.uk
.edu	.edu in an address indicates a university: for example, www.uwi.edu – The University of the West Indies
.bb	Barbados's country extension. Other country extensions include .tt for Trinidad and Tobago and .lc for St. Lucia
.org	.org in an address indicates a non-profit organisation of some kind: for example, www.rss.org.bb is the Regional Security System located in Barbados (.bb extension)
.gov	.gov in an address indicates a government department or organisation: for example, www.bgis.gov.bb – the Barbados Government Information Service
.net	.net is a network or an Internet service provider: for example, www.sunbeach.net
.html or .htm	.html will often appear at the end of an address and indicates that it is a file which contains hypertext: that is, a web page

You will see addresses that start http://. The http tells you that it is a **website**. To save you time, most browsers today do not require you to type the 'http://'. Instead, you just type 'www' followed by the rest of the address. Sometimes you may also see an address that starts with 'ftp'. FTP sites are not websites, but sites that allow you to transfer files across the Internet.

The name of the web server is next in the URL. A web server is a computer which uses special software to transmit **web pages** over the Internet. Many web server names are prefixed by www, for example www.caribsurf.com, www.sunbeach.net. If you enter the web server name into the web browser, you will see the **homepage** for the site. This is like the title page in a book from which other related pages may be accessed. You will get a message if there is no homepage available.

After the web server name comes the folder where the file is located then the name of the file being retrieved. Typical file name extensions on web pages are htm or html.

The web is an information retrieval system which enables users to connect from one website to another via hypertext links on the page. That is, when you click on a link, you are taken from one website to another, which may be on the same computer or a different computer at a remote location.

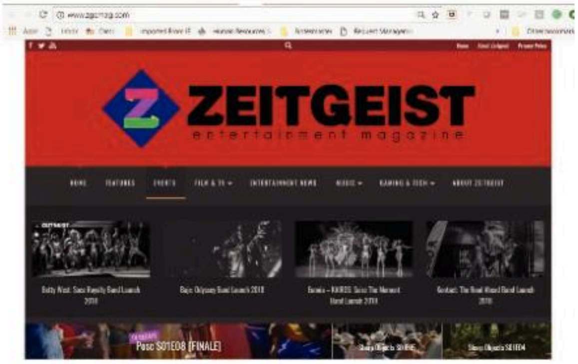


Fig 3.11 The Internet homepage of online Caribbean newspapers

If you do not know the URL of the site you want, you can use a search engine. A **search engine** is a software application that finds websites using keywords. Search engines have their own websites, such as www.google.com.

Whenever you find a site that you think you would like to visit again, you can 'bookmark' it, by adding it to your list of favourite sites. By opening your list of favourite sites, you can go straight to any site you have bookmarked without typing the URL or using a search engine.

Search engines index the words on billions of web pages. This indexing is undertaken by software robots (also known as spiders) that continually search the web for new sites or updated web pages. Indexing web pages in this way allows you to search using keywords.

Internet cache

When you are using the Internet, your web browser stores pages and files on your hard disk as you view them. These pages and files are stored in a temporary Internet files folder. This is known as a **cache**.

The caching of 'temporary' pages and files is important, as it speeds up the display of pages of sites that you have already been to. This is because a computer can access files more quickly from hard disk than from the web.

Blogs, vlogs and podcasts

Some Internet users post frequent items of commentary, descriptions of events, graphics, video or audio (**podcasting**) to personal websites. This is also called '**blogging**' for posts of text or picture entries or 'vlogging' for posts of video entries called 'vlogs'. Blogs or vlogs can be posted on any subject, and readers/viewers can reply to the post.

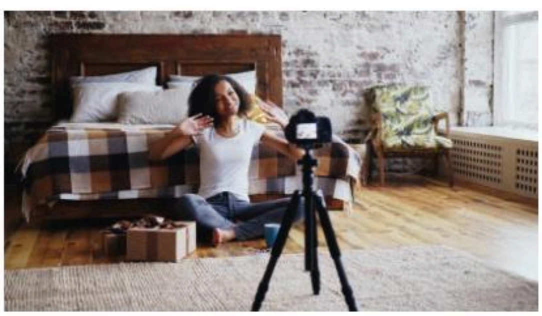


Fig 3.12 Vlogging is a popular way to share information

Creating web pages

Hypertext Markup Language (HTML) is a text-based language used to create web pages for display by a web browser. It is a formatting language, since it consists of codes which instruct the browser how to create, format and display the information on the web page. The data to be displayed on the pages is written as plain text and the formatting codes are written amongst the data (appearing to 'mark up' the data) in the document.

Email

To send an email message you need to have an email address of your own and know the email address of each intended recipient. An advantage of using email is that files containing pictures, sound, video and text can be attached to the message. Also, more than one file can be attached and sent with one email message. When an email is sent, the recipient does not need to be online. The message is stored in an email list for the recipient to read. One email can be sent to an individual or a group of people simultaneously.

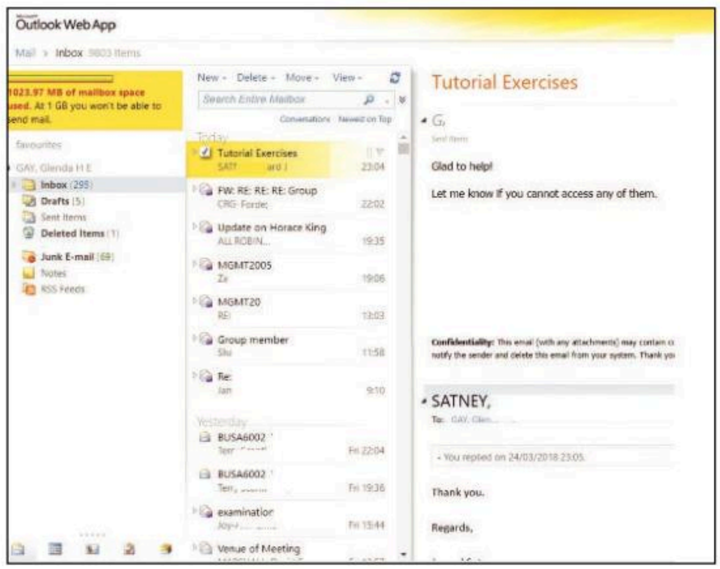


Fig 3.13 There are different web apps for storing email messages

Here are some advantages of email:

- Ordinary mail takes several days, but email can be sent immediately, and replies received as soon as recipients check their email.
- Emails do not have to be as formal and structured as typical letters.
- There is no need to get stamps, envelopes or paper, or go to a post box or the post room in a company.

Disadvantages of email include the following:

- Not everyone has access to a computer or the software application to use the email facility.
- Emails are not as private as personal letters.
- Replies are dependent on the recipient accessing the email and reading the message.

Voice over IP (VoIP) is an Internet protocol used to convert the sound of voice into digital form and transmit it over the Internet. Software applications such as Skype enable users to use the Internet to make telephone calls to others with or without another Internet connection. A major advantage of VoIP is that some users avoid paying international call charges compared with using an ordinary telephone service. A smartphone (Fig 3.14) is an example of a wireless device that can deliver VoIP, access email and be used for instant messaging and browsing the Internet.

Fig 3.14 Smartphones are an example of a wireless device with VoIP capabilities

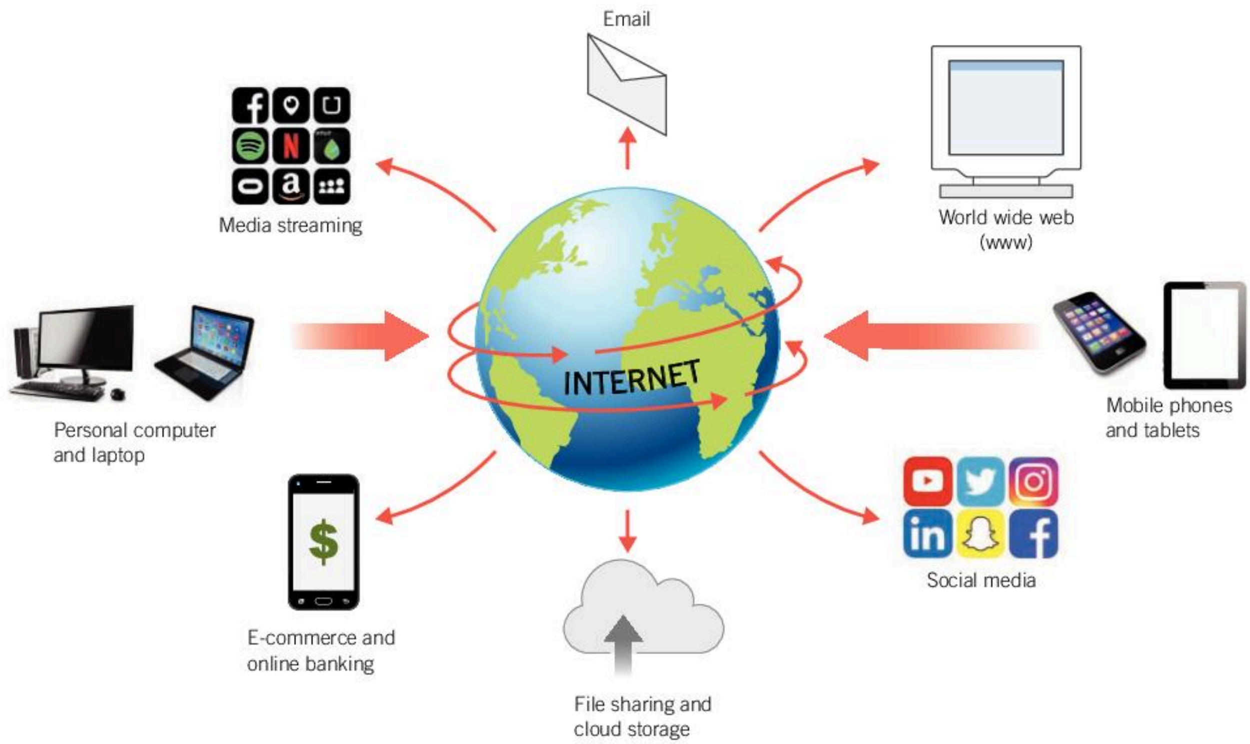


Fig 3.15 The main services provided by the Internet

Table 3.5 *Advantages and disadvantages of the Internet*

Advantages	Disadvantages
◆ You can find information on the web on virtually any topic you like ◆ There is enormous education potential, particularly: – collaboration between students (and teachers) on projects of interest – simulations, such as dangerous experiments, can be shown on the web – research and finding out more information – gathering of data, such as weather data – access to online experts – to explore and to have fun – information on the web can be multimedia: that is, text, graphics, video, animation and sound ◆ With faster access to the Internet, it is possible to have interactive games and TV on demand ◆ Some people can now work from home rather than in an office ◆ Many commercial organisations advertise, sell goods or provide services on the net: for example, shopping and banking	◆ The cost of computer equipment, connections and telephone charges can be high ◆ There is no control on the quality of information available on the Internet, therefore some information may not be accurate or may be highly offensive, such as racist propaganda. Also, some material is illegal and obscene, such as child pornography ◆ Security – many schools, colleges, businesses and other organisations access the Internet via a computer network. It is possible for hackers to gain access, via the Internet, to the network ◆ Searching for information can be difficult unless the user knows how to narrow down searches in a search engine ◆ It is difficult to protect copyright material: for example, it is easy to download copyright music without paying for it ◆ It is possible to download computer viruses that can harm data held on a computer or on a network

Questions

1 List any three of the main services provided by the Internet.

2 Explain the purpose of the following devices:
- **a** modem
- **b** router
- **c** switch
- **d** network interface card (NIC) or network adaptor.

3 Name the type of network that is most suitable for each of the following:
- **a** allows you to use a landline phone while connected to the Internet
- **b** mostly associated with mobile phones.

4 What is the difference between a blog and a vlog?

5 What is the name of a text-based language used to create web pages for display by a web browser?

6 What is the name of the Internet protocol used to convert the sound of voice into digital form and transmit it over the Internet?

Multiple choice questions

1 Which of the following devices provides access to the Internet?
- **a** adapter
- **b** modem
- **c** router
- **d** switch.

2 A network that allows mobile and other devices to connect to it is called a:
- **a** LAN
- **b** MAN
- **c** WAN
- **d** WLAN.

3 Bluetooth allows for the exchange of data across each of the following, *except*:
- **a** long distances
- **b** short distances
- **c** wired devices
- **d** wireless devices.

4 The term for sending data from your computer to another computer on a network or the Internet is:
- **a** create
- **b** download
- **c** modify
- **d** upload.

5 Which of the following connections has the fastest speed to send and receive large amounts of data?
- **a** dial-up
- **b** satellite
- **c** wireless
- **d** leased line.

6 A type of network where no one outside an organisation is allowed access is called a(n):
- **a** telnet
- **b** extranet
- **c** intranet
- **d** Internet.

7 Each of the following features are typical of 2G mobile phone systems, *except*:
- **a** caller ID
- **b** Internet access
- **c** multimedia messaging
- **d** video streaming.

8 A double slash (\\) in an Internet address shows:
- **a** that it is a file
- **b** the web page on the computer
- **c** the path to where the resources are stored
- **d** the path to where the computer (server) is located.

9 To send an email, you need to have each of the following, *except*:
- **a** a file to attach to the email
- **b** your own email address
- **c** information to type in the email
- **d** the email address of each intended recipient.

10 Each of the following reasons are issues with using email, *except*:
- **a** emails are not private
- **b** emails can be sent immediately
- **c** not everyone has access to a computer
- **d** you don't know if the recipient has read the email.

Short answer questions

11 Eli creates videos about his favourite football matches to share with viewers on the Internet.
- **a** What input devices would be most suitable when he is creating his videos?
- **b** He needs to edit his videos so that they are about five minutes long. What is the general name given to this type of application?
- **c** Explain the process that can be used to place his videos on the Internet.
- **d** Explain what type of storage is used to keep Eli's videos on the Internet.
- **e** What generation of mobile network should his viewers have in order to watch Eli's videos on their mobile phones?

- **f** Eli checked the video on his laptop. He can watch it but there is no audio. Give two possible explanations for the lack of audio.
- **g** Within two days, Eli gained around 400 subscribers to his videos, who will be notified as soon he produces another one. Give one characteristic of the information that describes when videos are shared with his subscribers.

12 Jarad plays online games using his television, which is connected to the Internet. He then records videos explaining what he likes about the games.

- **a** What input device is most suitable when he is playing the games?
- **b** What type of television is most suitable for accessing the Internet?
- **c** Jarad is part of an online group that plays computer games. They must all register using their email address to access the games and join the group.
  - **i** Describe the other information that might be required during the registration.
  - **ii** Explain one type of check that is used to ensure that each member enters the same information each time they log on.
- **d** As members play an online game, the number of points is shown in the top-right corner, along with the names of the players who are joining the game. State the type of output that is displayed on the screen.
- **e** State the name of the protocol that allows Jarad to chat with other players while playing the game.

IMPLICATIONS OF MISUSE AND CYBER SECURITY

4.1 Computer vulnerability

Organisations spend considerable amounts of time and money trying to make sure that their information systems are secure against various hazards, both natural and man-made. The importance of securing computer systems, their data and their network access to the Internet cannot be overstated.

Computer vulnerability is a weakness or flaw in one or more computer systems, or connectivity to computer systems. This weakness can be used to gain access and even damage the system or its data. The fact that the system is exposed to the possibility of theft or damage is its vulnerability. A computer system's vulnerability includes its hardware, software, data communications and users.

Vulnerabilities of systems and their data can be classified as being from external and internal.

External sources:

- minimal or no protection of computer systems and their data from natural disasters, for example floods and other natural phenomena (hurricanes, earthquakes, volcanoes)
- lack of protection from electrical power surges and spikes that could damage computer hardware, software and stored data files
- terrorist activities that target buildings or rooms with computer systems, for example bombings, arson.

Internal sources:

- errors by employees who overwrite or erase data
- no backup procedures in place for data files
- hardware and software not kept in locked rooms or passwords not created to access software
- internally produced software (known as **proprietary software**) which may be flawed and may as a result damage data
- lack of anti-virus programs to scan email attachments for viruses
- former employees whose passwords and security information have not been removed from the system
- employees who attempt to fraudulently obtain money using the company's name, for example by receiving payments for non-existent orders.

Fig 4.1 Power surges could cause damage to computer hardware

Threats and security

A security threat attempts to take advantage of a vulnerability or weakness in a system or its data. It indicates a possible danger to one or more computer systems, or by extension, a network. **Computer security** refers to the protection of hardware and software resources against their accidental or deliberate damage, theft or corruption (in the case of software). Data security is the protection of data against intentional or accidental damage.

Computer users can represent the greatest threat to a company's computer system security. Only authorised persons should have access to the computer systems of an organisation. Computer networks are structured so that each user has access only to the various programs and data they need for performing their duties. Each user, for example, is provided with a username and password with which they log in to use network resources.

Deliberate damage

Hacking is the unauthorised access and use of networked or stand-alone computer systems to steal or damage data and programs. Deliberate damage can occur when there is a planned attempt to bypass all legitimate access restrictions. This damage usually occurs when security monitoring is not enforced. Network access logs should be maintained by network administrators to observe the resources being used at any time by users and the time of their logging in and logging out. These software access restrictions are necessary to ensure system security is maintained.

Accidental damage

Accidental damage to computer data occurs through genuine errors by computer users, such as overwriting the most recent data or entering incorrect commands. Damage also occurs as a result of **viruses** transferred from secondary storage devices or via the Internet.

Data communications

Valuable information is transferred via electronic channels to save time. Information is often needed to make vital decisions that depend on the content of the communication. However, all electronic transmissions can be intercepted by persons other than the intended receiver. Such efforts may represent deliberate attempts to access sensitive information.

A cyber threat is an unauthorised attempt to access a system, device and/or network via the Internet. Cyber security focuses on stopping threats that attempt to access a computer or other systems in the network. It protects the network by maintaining logs on attacks and attempted breaches, monitoring sources of attacks and protecting against future ones.

Fig 4.2 Cyber security focuses on stopping threats to systems in a network

Questions

1. Name two external and two internal sources that could make computer systems vulnerable.
2. Answer the following questions based on the terms security threat, computer security and data security. State the term that describes:
   - **a** the protection of data against damage
   - **b** the protection of hardware and software resources against damage
   - **c** an attempt to take advantage of a weakness in a system.
3. Select the appropriate beginning for each of the following statements:
   - **a** Deliberate/Accidental damage occurs when there is a planned attempt to bypass all computer login requirements.
   - **b** Deliberate/Accidental damage occurs as a result of viruses erroneously transferred from secondary storage devices.
   - **c** Cyber threat/Security is an unauthorised attempt to access a system via the Internet.
   - **d** Cyber threat/Security maintains logs on attacks and attempted breaches.

Organisations gather information from a wide variety of sources, including their employees, customers, suppliers and competitors. When people voluntarily provide information to organisations, it is usually for a specific purpose such as hospitals, clinics and health insurance agencies.

Measures should therefore be in place to ensure that information is not misused. However, security breaches are common. The use of information for purposes other than those for which it was originally intended is also common. Agencies may provide mailing lists to other companies seeking potential clients. For example, the names and addresses of persons between 18 and 25 earning above a given salary level may be sold by a bank to an associated insurance agent as targets for direct advertising. If you subscribe to a computer magazine, you may receive a letter from another company trying to sell you software. You may not mind this, but you should have a choice as to whether your personal information is passed on.

Proprietary data and software

As organisations become increasingly dependent on their information systems, it becomes more important to protect those systems and the data they contain. The data and software developed and used exclusively by the organisation is known as **proprietary data** and must often be used by employees for day-to-day operations. Organisations go to great lengths to protect the integrity and security of this data.

Computer fraud

Developments in computerised systems have contributed to a growth in electronic transaction processing and the use of computers to misuse information. This has led to a rise in computer-based fraud. The following examples show various ways in which information can be misused.

Propaganda

The use of computer systems to distribute information has inevitably resulted in their use for spreading both beneficial and harmful material. The widespread use of the Internet by computer users has created a readily accessible means of transmitting such material. In some countries such **propaganda** may be used to sway public support in favour of one party group or in an attempt to discredit opposing groups.

Identity theft

Criminals use computerised systems to steal people's credit card information, date of birth and other personal details that are typically used by banks to prove who you are online or by telephone. They then use those identities to make expensive purchases or facilitate cash transfers by using your information to make others believe that you are conducting the online transaction.

Identify theft can be prevented by:

- checking bank and credit card statements for unusual purchases
- using a secure website when making online purchases
- not making online purchases using a debit card which is connected to your main source of funds
- not using public computer systems to enter personal information.

Financial abuse

Another example of computer-based fraud is where individuals have gained unauthorised access to financial accounts and changed the details of those accounts to their advantage. There have also been examples of people setting up websites for companies that do not exist in order to accept people's credit card payments.

Phishing attacks

Phishing attacks involve the use of websites and email messages that try to trick you into entering your personal information. They may appear to look as though they are from an official organisation such as a bank or university in order to trick you into typing personal information such as your credit card number or password in a form or in reply to an email.

Other examples include email messages asking you to send money to help someone who will repay it at a later date. You should ignore these messages, as they are intended to steal money from you. Avoid downloading attachments in email messages from senders that you do not know since the attachment may contain a virus or malware that searches for passwords and other personal information.

Denial-of-service attack

A denial-of-service (DOS) attack occurs when computer systems or networks are overwhelmed with so much data and processing that it makes it difficult or impossible for legitimate users to access their computer systems, devices or other network resources. This type of attack is similar to 20,000 students trying to access the CXC web portal at the same time to see their results online. Signs of an attack include:

- a decrease in network performance, especially when attempting to open files stored on the network or the cloud
- difficulty or inability to reach a regularly accessed websites or any website
- receiving lots of junk email.

This results in an inconvenience to a majority of users on the network although the person who caused the attack usually intended to sabotage only an organisation or individual.

Industrial espionage

Some organisations try to gain an advantage over their competitors by illicitly gaining access to information about their marketing strategy, latest research, expansion plans and so on. In the past they would have done this through break-ins, illegal photographing of documents, and insiders passing out information. Now it can be achieved by hacking into organisational databases and viewing the information they contain.

Electronic eavesdropping

It has been shown that it is possible to gather data from a computer from a distance, by using commercially available equipment which can receive and process the radiation emitted by the monitor. The data being displayed at the time can then be observed without the knowledge of the computer user.

Electronic eavesdropping is the use of electronic devices to monitor electronic communications between two or more groups without the permission of any of the communicating parties. This includes computer data communications, voice, fax, phone and email. Some computers can be modified to intercept information being transferred in any electronic form along a communication channel such as telephone lines, radio waves and so on. In some companies, it is the policy for all electronic communications to be monitored, including the telephone and email messages of their employees.

When this is done by unauthorised persons, however, the threat of invasion of privacy becomes real. It is a good idea to avoid transmitting sensitive information in electronic form unless there is an encryption system in place to ensure that the data is secure.

Most companies ensure that their data is encrypted (often by the communication software) before it is transmitted. If intercepted by the wrong persons, it is useless since the information is unreadable. The intended receiver will have the decryption key with which the data can be decoded and read. However, even this is often not enough to stop the most persistent eavesdropper from intervening.

Software and music piracy

Many software programs and music files can be accessed online by users from anywhere in the world. However, these files are legally owned by individuals or organisations. There are rules or licences for all programs and music specifying the permissions and limitations on how programs or music should be used. Therefore, when you use an online program or listen to a recording of a song, there are some restrictions on what you can do with it.

Software or music piracy occurs when someone does not abide by the rules to obtain permission from an owner. This type of piracy results from illegal use, sharing, selling or distribution of copies of software or music, and prevents the rightful owners from getting money due to them for their creative efforts.

Unauthorised access

This is usually referred to as 'hacking'. Hacking involves trying to electronically 'break into' a system to which the individual does not have authorised access. The purpose behind this infiltration varies; some hackers see their activities as a form of game-playing, where they match their computer skills against those of an adversary and just gaining access is sufficient for them. Others are more destructive in their intentions: they target organisations that they are antagonistic towards and commit acts of 'electronic vandalism' such as changing critical data.

Questions

1 Explain the difference between:
   - **a** computer fraud and propaganda
   - **b** phishing and identity theft.

2 For each of the following state the type of software threat and indicate whether it affects a single computer or multiple systems:
   - **a** trying to electronically 'break in' without authorised access
   - **b** hacking and viewing electronic information
   - **c** using electronic devices to monitor electronic communications
   - **d** overwhelming a system with so much data and processing that it makes it difficult to access.

Whether a threat is deliberate or accidental, all methods should be taken to prevent it from occurring or to minimise its effects. A countermeasure is a procedure, either physical or logical, that recognises, reduces or eliminates a threat.

Data protection refers to computer users who can protect their data against loss or damage. It also refers to data protection laws, which set down rules about what information can be kept by others about you.

Surveillance

Computer surveillance involves the use of technology to gather information from the user and from the computer, often without the user's knowledge. Monitoring entrances and exits together with methods to identify authorised personnel is a typical method used to identify a threat. This method of security is employed to protect the physical surroundings, that is the building and rooms with computers in them. Common approaches to physical security include:

- closed-circuit TV monitors
- electronic alarm systems
- computer-controlled locks that check employee badges
- biometric recognition, such as fingerprints, retina scans and voice to authorise entry to different rooms or buildings
- access codes.

However, there are some negative consequences of computer surveillance, including:

- loss of privacy for the user
- lack of security
- potential misuse of information, possibly for monetary gain
- difficulty in determining the source and possible scope of surveillance activities in some organisations
- limited measures to prevent computer surveillance.

Depending on the purpose of the surveillance, it can be used to create or prevent an attack. There are several techniques for surveillance, including monitoring software and hardware devices.

Monitoring with utility software

All data that passes into and out of a network can be monitored. This is also known as **'packet sniffing'**, where a packet is the message being checked. Messages can be monitored using utility software or by using a computer on the network which can observe all packets passing through the network.

Monitoring with hardware devices

Physical or hardware devices called **'bugs'** are keystroke loggers implanted in the keyboard. This device can record all keystrokes made by the user over a period of time. The device can then be retrieved and the keyed information can be reproduced. Other more sophisticated devices, which can obtain more information, can be inserted into the computer itself. The disadvantage of hardware devices is that placement and retrieval requires physical entry into the place where the computer is stored. This can be a legal offence and is a violation of privacy without legal authorisation.

Protection from nature

Data should also be protected from natural disasters, including the risk of fire, storm damage, dust and humidity. Organisations use fireproof cabinets and safes to keep critical data stored on media such as optical disks, tapes and microfilm to protect against such hazards. Computer systems should make use of electrical surge protectors to protect computer hardware against electrical surges and spikes. The effect of power outages can be minimised with the use of an **uninterruptible power supply (UPS)**. This device contains a battery which supplies equipment with electricity during a power outage so that data can be backed up and a normal shutdown of the hardware can be performed (Fig 4.3).

Fig 4.3 Uninterruptible power supply (UPS) provides electricity for a short period after power outage so that computer data can be saved and systems can be safely shut down

Protection from theft

Some schools often lock computers to the desks to prevent theft of the system units and peripherals. However, there is still the theft of memory chips, hard drives, CD and DVD drives, printers, inks and other accessories. Organisations should limit access to authorised persons and maintain records and logs of computer usage.

Computer viruses

A computer **virus** is a program that infects computer files and makes them do something unexpected or damaging. A copy of the virus program is inserted into a computer file, and when the file is used and loaded into memory, other files become infected. Computer users are unaware that a program or a file has become infected. If one of the infected files is sent by email, or given to other users on a device such as a USB memory stick, then other computers are infected and the virus spreads.

Viruses are an increasing threat to computer systems. In 1986, there was only one known computer virus. Today, hundreds or thousands of new viruses appear every day.

There are three main types of virus:

- those that infect program files. The virus code is attached to program files and when the program is loaded, the virus is loaded as well.
- those that infect system or boot files. The boot file is a small program that tells the computer how to load the rest of the operating system. By infecting this boot file, the virus is loaded into memory and is able to run whenever the computer is on.
- macro viruses. These are written in a language associated with an application such as Microsoft Access. The macro virus is carried by a database file and is executed when it is opened.

A **worm** is another electronic threat. Unlike a virus, it does not require a host program in order to be transmitted. Worms can be transmitted via email and are capable of copying themselves into memory. Mass mailing worms can create infected email messages and send them to the addresses saved on the infected computer.

Preventing viruses

Virus protection programs not only scan a computer's data for harmful viruses but also protect from and intercept viruses attempting to infect data in system or application software.

The best way to protect a computer against viruses is to:

- Install anti-virus software. **Anti-virus software** protects the operating system, programs and files against viruses. It regularly scans a computer for viruses and then removes any viruses that are found. Anti-virus software can be set up to automatically check storage devices, Internet downloads and emails for any viruses. Because new viruses are being discovered on a daily basis, leading anti-virus software products such as Avast, AVG and

McAfee have anti-virus updates automatically downloaded from their websites to keep protection up-to-date.
- Turn on program virus protection. Some programs – for example, Microsoft applications – have built-in macro virus protection. When this is the case, make sure that it is turned on (enabled).
- Try to know the origin of each program or file you use. In the age of the Internet, this is very difficult – hence the need for anti-virus software. As a rule, beware of free software and software downloaded from the Internet.
- Never open an email attachment that contains an executable file with an extension EXE, COM or VBS, even if you know who sent the email. This is how many viruses are spread.

Protecting files and databases

A database contains the raw data for information. Often the databases in an organisation are its lifeblood. Companies therefore cannot afford to lose records. Maintaining several generations of backups as well as archives of all its critical files are advised. The master and backup files should be stored in fireproof safes, or preferably in separate buildings away from the main computer centre.

Backups and archives

Making **backups** (copies) of files is always important. For businesses and other organisations that depend on databases it is essential. Files can become damaged, corrupted or even lost. Think what would happen to travel agents if they could not use a database for booking flights or to doctors who could not access patients' details. To prevent situations like this happening, the regular backing up of files is essential. If a file does become damaged or corrupted, then the files, and the data they contain, can be restored (or recovered) from the backup copy, and business can continue as normal. How often backups are made depends on how valuable the information is.

Fig 4.4 Files can be restored from backup copies

Most modern networks have software which automatically performs backups of data files to magnetic tape or CD-RW. Backups can be performed after each work day, every other day, or as often as deemed necessary.

Some backups are also stored in a remote location to protect against disasters such as hurricanes, volcanoes, floods or earthquakes that would destroy any backups in the immediate vicinity, along with other equipment. Another alternative, called remote data backup, stores backups in cyberspace. Users and companies buy online storage for easier access to data. However, data stored online is prone to deletion if the online storage company goes out of business.

An archive preserves files that you no longer need on a regular basis. By putting them in an archive, storage space on your hard disk (or network drive) can be released for use by current files. Archives can be extracted if the need arises, usually for reference. For example, an organisation may preserve archives of past ledgers, receipts and tax forms for future reference only.

Network and cyber security

Companies address cyber threats with **encryption** or **decryption** techniques. They encode data before transmission so that it appears unintelligible unless it is decrypted using a software key.

Users on a network can each be given a username with an individual password. This prevents other users accessing an individual's file, changing program settings, or installing, copying or deleting software. Other techniques include preventing virus attacks through networks, email or by sharing secondary storage devices and media.

Copyright and piracy

Copyright is the name given to the protection in law of the rights of the person(s) responsible for creating such things as text, a piece of music, a painting or a computer program. The illegal copying and stealing of software costs the software industry millions of dollars a year. A copyright law would make it a criminal offence to be caught copying or stealing software. It would also make it an offence to:

- copy or distribute software without permission
- run copyright software that has been bought on two or more computers at the same time unless the software agreement (licence) allows it.

The Intellectual Properties Affairs office in a country would be responsible for enforcing the law on copyright and campaigning against software piracy (Fig 4.5).

Fig 4.5 Software piracy is against the law in many countries, but is not outlawed worldwide

Software piracy is the theft of computer programs and the unauthorised distribution and use of these programs. In the Caribbean, countries are enforcing copyright and piracy laws for music, printed material and software.

The main types of piracy are:

- copying software (and its packaging) to try to make it look like a genuine product
- copying and selling recordable CD-ROMs that contain pirated software
- downloading software from the Internet; just because software can be downloaded from certain sites does not mean that it is free or legal for you to download it
- using software on more computers in a network than the number of computers for which there are software licences.

Because of all of these activities, many countries have enacted laws which make it illegal to misuse computers. People found guilty receive a large fine or a prison sentence. For example, it is illegal to do any of the following:

- deliberately plant computer viruses that damage program files and data
- copy computer programs illegally (computer piracy)
- hack into a computer with the intention of seeing or altering information
- use a computer to commit crimes (fraud), for example to create a fictitious worker and get money paid into this non-existent person's bank account
- use your employer's computer to carry out unauthorised work.

Some countries also have legislation that seeks to protect the individual from the potential misuse of personal information. Contents of such legislation include:

- Information should be used only for the purpose for which it was provided.

- The individual has the right to examine the contents of any personal record representing the individual.
- The information must be accurate. Information should be periodically updated to be a true reflection of the individual.
- Information should not be held for longer than necessary.
- All measures necessary for ensuring the security of the information against physical and electronic threats should be in place.
- The privacy of the individual should be protected.

Questions

1 Explain why each of the following methods of file storage is important:
 a making backups
 b archiving.

2 Indicate whether the following statements are true or false:
 a Virus protection programs only scan a computer's data for harmful viruses.
 b Software piracy is the authorised distribution and use of computer programs.
 c An individual has no right to examine the contents of any personal record representing him/her.
 d Information should not be held for longer than necessary.
 e The privacy of the individual should be protected.

3 State the type of protection for each of the following descriptions:
 a to keep critical data stored on media such as optical disks protected from risk of fire
 b to protect computer hardware against electrical surges and spikes
 c to prevent theft of the system units and peripherals
 d to monitor suspects, often without their knowledge.

There are numerous examples of how information systems play an increasingly important part in your life – from programmable televisions and remote-control devices to e-commerce using the Internet. It is important therefore to be aware of, and be able to discuss, the following effects of computers.

Table 4.1 *Effects of IT in the workplace*

Social impact
◆ Less social contact among employees
◆ A large increase in the use of computer games (time wasting; no social contact; addictive; some are educational)
◆ It may become easier to keep in touch with people (email, social media)
◆ Privacy considerations – how secure is personal data?
Work patterns
◆ The Internet and WANs have allowed employees to work from home
◆ Advantages include flexible hours, a more relaxed atmosphere and no commuting
◆ Disadvantages are a lack of social contact and possible disruptions or distractions
◆ Advantage to company includes no need to provide office space, heating, refreshments and so on
Cashless society
◆ Workers are automatically paid by electronic funds transfer (EFT) into their bank accounts
◆ Credit and debit cards are used more for payments
◆ Main advantage is no need to carry cash
◆ Disadvantage is the possibility of fraud or lost or stolen cards
Employment
◆ Practical skilled jobs on the decline
◆ Possible redundancies if a more efficient IT-based system replaces workers
◆ New jobs created in IT-related fields such as programmers, systems analysts, robot maintenance
◆ Workers need to be retrained
Health and safety
◆ Attention needs to be paid to posture problems from sitting for long periods at a computer
◆ Radiation hazards from monitors and eye strain
◆ RSI (repetitive strain injury)

Changes in the workplace

The ICT revolution has brought about widespread changes in the workplace. Most offices now use computer systems, often connected by a LAN or WAN. Most offices will therefore have their networks connected using cables or with wireless technology. Applications such as word processors, databases and email, and mobile telephones are used by millions of people every day. Video conferencing via WAN and the Internet enables meetings to take place without the participants having to leave their offices.

Computers are used in many economic sectors and, as the need for managing information becomes more important in these areas, employees are required to become more skilled in the use of information technology to perform their duties. The skilled use of hardware and software is necessary for most occupations that involve information collection, processing and distribution.

Loss of jobs and retraining

Computers are now being used for jobs that were previously done by people. For example, as more customers buy products online, staff in stores may be reduced. The use of email may replace the purchase of stamps and delivery of mail, but, on the other hand, there could be an increase in the delivery of products that were purchased online.

Work that has been lost includes:

- repetitive jobs, such as telephone operators who direct calls to office extensions
- dangerous jobs, such as defusing bombs or working in areas with extreme heat or cold
- office jobs that can be automated or take less time using ICT skills, for example typing or re-typing documents that can be saved and edited for future use.

Most jobs now require some ICT skills and so, for some people, retraining is necessary to remain in the workforce. Learning to use a computer and typing quickly are among the more important aspects of retraining. Some people take short courses or learn new on-the-job skills to remain marketable. IT skills help to keep funds in the business since completing jobs in-house using IT saves the money it would cost to **outsource** them.

Telecommuting

Work can now be accessed by employees in their location instead of by the more traditional method of travelling to work. Millions of people, known as telecommuters, teleworkers or remote workers, now work, on a full- or part-time basis, at home or move around the world using a computer or mobile device to communicate with their employers and/or clients.

This has the advantage of reducing office space, with less electricity or air-conditioning usage, but telecommuters must also face higher utility bills if they are working from their homes. Some businesses may compensate their employees for this added expense.

However, telecommuting can be isolating for the employee, as one of the more enjoyable aspects of a job in an office is often socialising with other people. Distractions in the home environment may reduce productivity.

Social concerns

The widespread use of information systems has led to more efficient ways of working and to a decrease in the hours that many people have to work. This allows more time for people to spend on leisure pursuits. Without a second thought, millions of people use personal computers, mobile devices and information system devices such as video recorders. The growth of telecommunications, including the Internet, has led to a situation where people can share information in a **'global village'**. Distance is no longer an issue, with people communicating as if they were living closely together in a small village.

There is disagreement about the effects on young people of spending a long time using computers and playing computer games. Some people argue that prolonged use makes youngsters withdrawn and less likely to socialise with others, whereas others argue that playing games can develop problem-solving skills and encourage collaboration and teamwork.

Health concerns

Millions of people use computers regularly for work, education and leisure. As with any other equipment, computers should be used safely and in a way that doesn't harm users' health. This is important, as there is evidence that using a computer for a long time, and not properly using computer equipment or furniture, can affect your health and result in injury. Some examples of this are given in Figure 4.6.

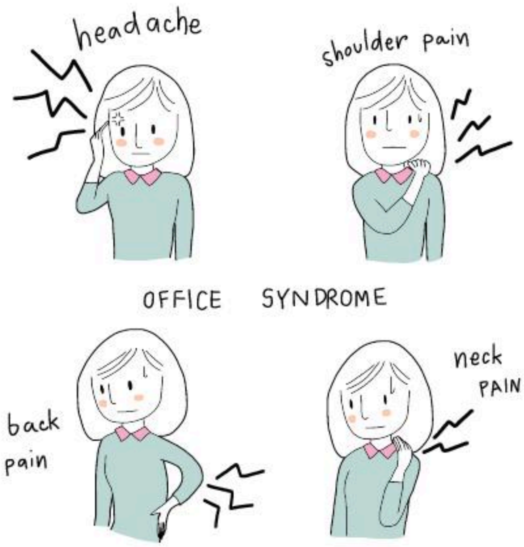


Fig 4.6 Using a computer for a long time without proper furniture and posture can result in health concerns

Repetitive strain injury

Aches and pains, swelling and difficulty of movement are all symptoms of disorders affecting fingers, wrists, arms and neck that can be caused by lengthy or improper use of computers. The common name for these disorders is **repetitive strain injury (RSI)**. RSI can be extremely painful and is caused by long and regular periods of typing or using the mouse, or even poor workstation setup.

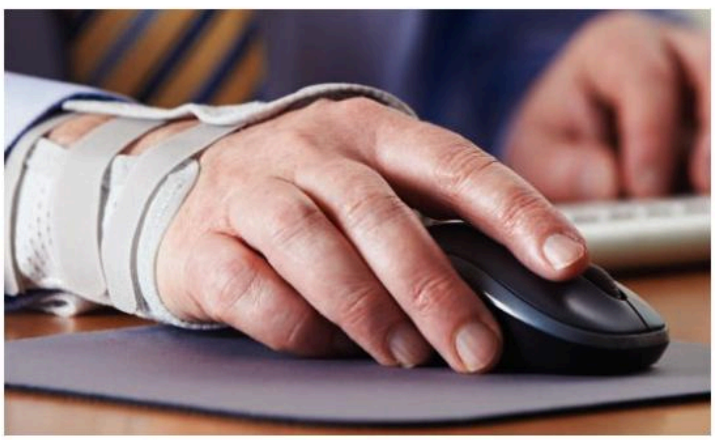


Fig 4.7 Repetitive strain injury (RSI) can be caused by long periods of typing and using the mouse

What can be done to stop RSI?

- Take regular breaks from the computer or change activity. Short breaks of 5–10 minutes every hour are recommended.
- Place the mouse immediately to the left or right of the keyboard.
- Hold the mouse loosely and don't use the mouse continuously for long periods.
- Use wrist and/or arm rests.
- Arrange your desk so that your keyboard is easy to use, tilted and separate from the screen.
- Make sure that there is enough space in front of the keyboard to rest your hands or arms.
- During regular breaks, stretch and move your hands, wrists and neck as a form of exercise.
- Relax – RSI can be caused by tension.

Back problems

Back problems can be caused by poor or incorrect posture when using furniture or equipment.

What can be done to stop back problems?

- Use a chair that is adjustable in height, able to swivel and that has a tilting backrest.
- Make sure that the chair is at the correct height for you to use the keyboard and screen.
- Sit in a comfortable position and regularly change the way you sit (consider your posture).
- Use a desk large enough to take all the computer equipment.
- Take frequent short breaks and stand up or walk around.

Eye problems

Eye strain is the most common health problem linked to using computer screens for long periods. Eye problems are also linked to poor lighting, glare and being too close to, or too far from, the screen. The size of fonts and colours used in software can affect the eyes.

What can be done to stop eye problems?

Computer screens should:

- not flicker
- have brightness and contrast settings that can be easily changed
- tilt and swivel
- be positioned to avoid glare and reflections from lights or windows, and be fitted with glare-reduction filters.

Stress

Using computers, or having your work monitored by computers, can be stressful. Also, modern communication technologies, such as email, portable notebook computers and mobile phones, mean that some people cannot take proper breaks as they can always be contacted immediately. This too can be stressful.

Environmental concerns

The widespread adoption of information systems has also had environmental effects. On the one hand, the need to power millions of computers has increased electricity consumption while, on the other hand, the consumption of electricity and other forms of energy has been reduced as computers carefully control air-conditioning and heating systems. Information systems have enabled **teleworking** from home. This can mean less travel to and from work and therefore a reduction in traffic pollution. Although the age of the truly paperless office is some years away, there has already been some saving on the use of paper (and therefore trees) as data is communicated and stored digitally.

Legal, ethical and moral effects

The legal, ethical and moral effects of information systems will continue to be an area of concern to users. A great deal of personal information is held on computers. The Data Protection Act tries to ensure that personal information is held and processed responsibly. Laws have also been passed to try to stop hacking and the pirating (stealing) of software. All of this raises some important ethical and moral issues, such as the following:

- How far should the law go in giving government officers, such as the police, access to everyone's personal data or emails in order to fight crime?
- How far should established and new technologies, such as closed-circuit television (CCTV) and microchip smart cards, be used to monitor people's activities?
- What will happen to people who cannot afford to buy, or gain access to, a computer system?

Table 4.2 *IT skills required in the workplace*

Category of worker	Skills required
Office employees	◆ Word processing and document preparation ◆ Budgeting – for example, preparing financial statements and invoices ◆ Communications – via fax, email, forum/newsgroups ◆ Basic troubleshooting of hardware and software
Teachers	◆ Word processing, spreadsheet manipulation ◆ Database management – creating and searching databases ◆ Preparing presentations ◆ Network use – accessing and using school LAN resources ◆ Operating hardware – computer systems and peripherals (for example, printers, scanners, multimedia projectors) ◆ Installation and basic troubleshooting of hardware and software
Engineers	◆ Software programming – the ability to design, test and implement new software ◆ Installing hardware and software ◆ Manipulating peripherals such as sensors, controllers and graphics tablets (design) ◆ Using communications systems – LAN, WAN, Internet

(continued)

Table 4.2 *IT skills required in the workplace (continued)*

Category of worker	Skills required
Medical personnel	◆ Word processing and document processing ◆ Expert system consultation, examining references for surgical procedures, maintain inventory of medical supplies ◆ Prepare budgets, medical bills, insurance claims using financial software for – example, QuickBooks ◆ Manipulate hardware, patient monitoring and imaging systems – for example, ultrasound, MRI and CAT scan technology ◆ Conducting teleconferencing meetings among doctors in different locations
Musicians	◆ Using music notation software for composing music and preparing lyrics ◆ Using MIDI (musical instrument digital interface) hardware to produce music and interfacing with computer systems to add instrument sounds, special effects ◆ storing and retrieving music tracks from optical storage media
Mass media personnel	◆ Word processing – used for preparing articles, news scripts ◆ Database searches and information retrieval – searching for past articles, news articles from other countries ◆ Communications using email, fax, forums/newsgroups ◆ Using hardware and software for film and sound editing before going to the final press
Law enforcement personnel	◆ Word processing and document preparation – used for preparing case reports, letters and so on ◆ Database searches – accessing records kept on known offenders
Movie industry personnel	◆ Word processing and document preparation – used for preparing movie scripts ◆ Animation – some movies are made with the use of computer graphics and animation for some scenes ◆ Accounting and budgeting software – used to create cost and income estimates for movies

Questions

1 Name two changes in employment if computers replace workers.

2 With increased use of computers, explain what causes each of the following health problems:

a back problems

b eye problems.

This topic lists the jobs of some personnel working in computer-related fields.

Computer support specialist: provides technical assistance directly to computer users who need assistance with a specific application.

Computer programmer: translates analyst-prepared specifications for software into algorithms and converts the algorithms into applications programs. The programmer will write, test and maintain the application software.

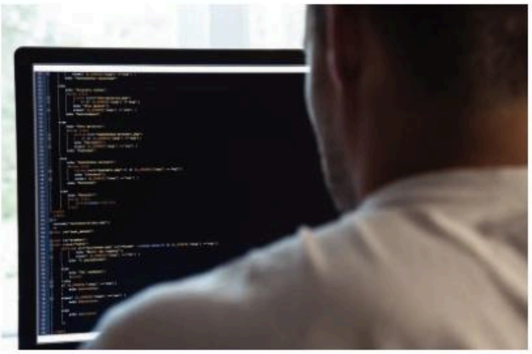


Fig 4.8 A computer programmer

Systems analyst: analyses systems currently in place to assess their suitability for computerisation or recommends upgrades for existing computer systems.

Database administrator (DBA): designs, creates and maintains the integrated database. The integrity and security of the database are also the responsibility of the DBA.

Network administrator: designs, develops and maintains local area networks and wide area networks, and schedules maintenance of the network components. Sets up access and security measures such as user IDs, passwords and firewalls. Also ensures that all shared resources, such as printers and disks, are monitored and working properly.

Network engineer: attends to any hardware faults and malfunctions in the equipment. Installs new systems and services computers.

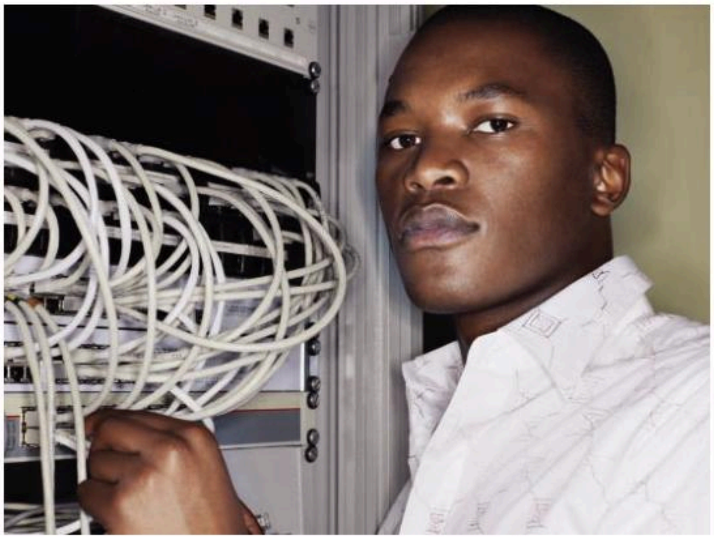


Fig 4.9 Network engineer working with a server

Social media specialist: communicates with the public using social media to create and share content using social media platforms such as Twitter. Manages their employers' social media accounts, working to build the brand's reputation.

Software developer: develops the applications that allow users to complete specific tasks on a computer or another device.

Systems administrator: monitors and maintains the system security. Determines the organisation's system needs and adds users to a network, and assigns and updates security permissions on the network.

Web developer: builds websites, which involves writing the programming code necessary for an efficient and stable website. Web developers oversee and direct the development of the website from idea stage to its final published state, ensuring that loading times are minimised so that users can access information quickly.

Questions

1 List three types of administrators that work in computer-related professions.

2 Explain the difference between the jobs of a computer support specialist and a social media specialist.

We need systems in almost every aspect of human life to prepare meals, maintain cars, complete our assignments and travel to work or school. An **information system**, however, is responsible for the collection, processing and overall management and distribution of information.

Computers and communication devices can manage large amounts of information at a faster rate than manual systems, such as filing, sorting and mailing.

When choosing a computer information system for a particular situation, you need to consider:

- what hardware is used, such as input, storage and output devices
- what software is used, including the choice of custom-written, specialised and general purpose software
- what processing takes place
- what human–computer interface is used
- which people are involved and what work they do
- what data is required.

The first four points were discussed in Chapter 1. You can now apply this knowledge to decide which systems and applications are appropriate in various computer-related fields. Some examples are illustrated in this chapter, such as commerce, education, law enforcement, medicine and recreation. You should first recognise the advantages and disadvantages of computerised information systems, which are summarised in Table 4.3.

Table 4.3 *Advantages and disadvantages of computerised information systems*

Advantages	Disadvantages
• Save enormous amounts of paper and filing space • Rapidly find, calculate and sort data • Work automatically • Data easily imported (brought in) from another system or program • Data easily exported (moved or copied) from one system or program to another • Data easily entered (by keyboard or scanner) or updated • When computers are linked together in a computer network, more than one person can access the information at the same time	• Some systems can be complicated and/or require a lot of time to be spent on staff training • The computer(s) running the information system may not work due to an electrical failure or a hardware/software fault. If everything is computerised, no work can be done at these times unless backup power or systems are available • Data may be incorrect • Some people may attempt to access confidential information. Therefore, security is extremely important

Business

Commerce

Computer systems are used to help make organisations more efficient, cost-effective and responsive to the needs of their customers. Popular areas are research and development of new products and services, as well as marketing and the monitoring of trends in sales.

Research and development

Computers in this industry analyse existing sales data and the likely market for a new product. Appropriate hardware incudes network and personal computers to process images, scanners to input designs, and printers and graph plotters for producing new designs and advertising signs. Specialised software programs are used to create the detailed designs for the product.

Stock management

During product development and manufacturing, each product must be monitored very closely. Keeping an automated stock control system for any raw materials purchased can ensure that there is always an adequate supply for the manufacturing process. The system can also provide early notice to reorder materials before stock levels become critically low.

Marketing and distribution

Marketing departments inform customers of new and existing products. They can use computers to automate the production of advertising material, using word-processing and database software. Computers and scanners also allow vivid product pictures to be included in advertising.

Sales

You may know of small shops where computers are not used, and goods are still priced individually by hand. However, when prices change, the price labels must also be changed. Itemised receipts for the products sold sometimes have to be handwritten. Checking the stock levels in the shop before re-ordering items is done by individually counting the different items in the product lines.

Compare this with a business that uses a computer system. Goods do not need to be individually priced (Fig 4.10). This is because each item has a barcode that is swiped through a barcode reader at the point of sale (POS) computer terminal at the checkout. The price for each item is maintained by database software. All the items bought by a customer are automatically listed and added up and any discounts due to loyalty cards are given. Payment can be made using credit or debit cards using a reader. The money is automatically transferred through networked computers to the supermarket's account. A bill, listing each item that has been bought, is then printed and given to the customer.

Fig 4.10 A barcode reader can be used to check inventory and prices on products

Each checkout computer may be linked to a warehouse and the main computer system through a wide area network. As the items are swiped through the barcode readers at the checkouts, the stock levels of each product line are automatically updated. When the stock of a product gets too low, the product can be automatically re-ordered from the warehouse. The computer system can give managers instant access to sales figures so that they can see which items are selling well at any branch in the country.

Table 4.4 *Hardware and software for commercial applications*

Industry	Example of application	Hardware	Software
Marketing and distribution	◆ Automated direct mailing to inform customers of new products	◆ High quality printers for flyers and advertising material	◆ An inventory control system ensures supply to retail agents is efficient
Sales	◆ Monitoring of stock levels and instant payment of goods	◆ Point-of-sale terminals ◆ Use of credit or debit cards	◆ Software for e-commerce, selling direct to customers
Banks	◆ Electronic money transfers	◆ Networked automated teller machines (ATMs)	◆ Specialised ATM software ◆ Banking software

Banking

Banks now depend on computer systems to run their business. Funds are instantly credited and debited from customers' accounts using special banking software. Networked automated teller machines (ATMs) allow customers to withdraw cash and check their account balance. Credit and debit cards enable customers to buy goods and services at most retail outlets, with the purchase cost automatically debited (deducted) from the customers' accounts. Online banking is replacing the need to process millions of cheques. Customers can access online banking via computers or their mobile devices. Some of the services offered with online banking are:

- checking a bank balance
- transferring money between accounts and to other customers' accounts
- paying bills online
- viewing/printing current and previous bank statements
- applying for new accounts.

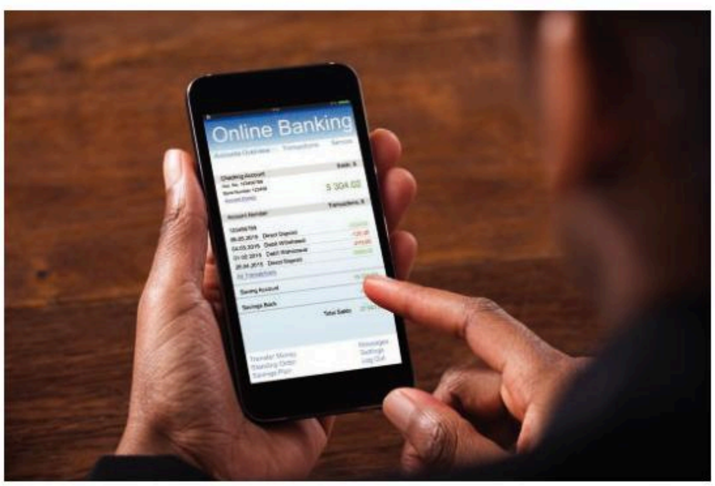


Fig 4.11 Online banking can be done at any time, from anywhere, using a mobile device or computer

Education

Databases

In schools, the collection and organisation of student information is made more efficient by using database management programs. Before widespread computer use, student information was kept on sheets of paper or index cards, or in folders kept in filing cabinets. With computerised database records, searches are faster, and information is produced when it is wanted.

Teaching and instruction

Software designed specifically for instruction is available for students and teachers alike. Computer Aided Instruction (CAI) and Computer Aided Learning (CAL) software can be purchased for many subjects and cater for students of any age. Students can use them to study topics at their own pace, take practice tests and monitor their progress as they move from one topic to the next. Software such as Moodle® also helps with group work, even if the group members are located in different areas of the country or the world. This form of collaborative learning helps people learn new information together.

Using online software, instructors can also monitor online quizzes and evaluate the results, including how long each student spent completing each question in the quiz (Fig 4.12).

See all course grades

Name	Attempts	High score
Denise	87.5% Thursday, 29 March 2018, 1:51 PM, (12 mins 50 secs)	87.5%
Claudia	50% Thursday, 29 March 2018, 7:52 PM, (39 mins 47 secs)	50%
Sandy	90% Thursday, 29 March 2018, 6:02 AM, (22 mins 24 secs)	90%
Paul	87.5% Wednesday, 28 March 2018, 10:09 PM, (25 mins 10 secs)	87.5%

Fig 4.12 Using Moodle software to evaluate the results of an online quiz

With so much information available on the Internet, information or even complete essays can be found online or purchased from others. Assignments obtained by these methods and submitted as is or slightly rearranged for grading is illegal. Using someone else's work or ideas and making others believe that it is your own is called plagiarism. Some schools and universities expel students for plagiarising and certificates awarded can be made 'null and void' if students have plagiarised.

Hardware devices used in classrooms include multimedia-ready computers, networks, multimedia projectors, printers, earphones and microphones for independent work.

Medicine

This area covers a wide range of applications. However, the most important ones are found in medical research, which includes access to online medical information and online health services.

Medical research involves using medical models and information systems which study the human body as well as storing details of patients and their illnesses.

Medical information systems

Most doctors today use a medical information program to keep details about their patients and their illnesses. Patient information can be brought up on computer screen while you are seeing the doctor. The medical information program, apart from having your name, age and address, will also have a record of your illnesses and of any drugs given to you. Once the doctor has found out the cause of your illness, and has entered the prescribed medication, the computer can print a prescription that can be taken to a pharmacist. Sometimes, the prescription can be sent electronically from the doctor's database to the pharmacy's database if the two are connected via an extranet.

Other medical health services, such as imaging and ultrasound services, can be connected to a network along with those of medical professionals and pharmacists. Patients' information, together with test results, can then be shared via the network. Medical personnel across the world can be given access to the network for consultations and faster diagnoses.

Expert systems

The **expert system** is one example of artificial intelligence that is designed to store a vast amount of data (known as a knowledge base) related to past aspects of the application area. It draws on this data, along with certain rules for processing, to come up with a 'prediction' for the outcome of a current situation. In the medical field, the expert system may provide a diagnosis when given a set of symptoms or image scans of the body.

Medical models

Modern medical whole-body scanners can collect a large amount of data about a person's internal systems. The data collected can then be processed on a special computer using customised software to produce a three-dimensional model of the whole body or a part of it. This information is usually collected as a series of 'slices' and the program 'glues' the slices back together to make the three-dimensional model. This model allows doctors to locate precisely, for example, a tumour, and helps them to decide what to do next (Fig 4.13).

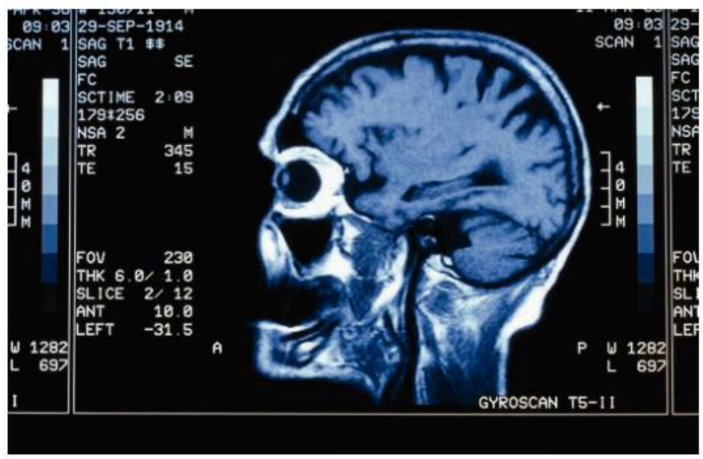


Fig 4.13 A slice image through the brain can be obtained by magnetic resonance imaging (MRI)

Virtual-reality simulations

Virtual reality uses software applications to create an artificial environment which gives users the feeling that they are part of that environment or reality. A special headset fits around the user's face, covering the eyes and sometimes the ears to block all sights and sounds from the immediate surroundings. Other images and sounds are then used to make the 'virtual world' seem more realistic. A user's sight and hearing are the two senses mostly used with virtual reality. However, some programs use touch as another sense for a more realistic experience. As an example, surgeons can now be trained to perform new surgical procedures without endangering life. A virtual-reality human model can be created, and a trainee surgeon can perform the operation.

The sensor and control systems connected to the operator can give feedback to the surgeon to create an illusion of the real thing. The feedback can be visual, through the imaging system, but more important is the feedback which gives the sense of touch. This will help the surgeon to master the safe manipulation of the surgical instruments.

Virtual reality is also used in actual surgery. For example, the 3D image of a brain tumour can be created from a series of slice images produced by scanning the affected brain, using Magnetic Resonance Imaging (MRI). Virtual reality can also be used in other training simulations (for example, pilots or deep-sea divers) and interactive games for all ages.

Law enforcement

Computer systems help security forces around the world in their fight against crime. Millions of criminal records are held on computer database systems throughout the world. Each year computer technology is used to process requests for information from police officers who want to find information about suspects, robberies and stolen vehicles. Searching for crime statistics, storing new criminal records, accessing databases in other countries and communicating with army mobile units are just some of the uses made of computers in law enforcement. This information can then be provided to officers in seconds. Regional security systems also have networks that participating countries in the region use to share surveillance information.

A fingerprint system can provide fast access to databases of convicted criminals' fingerprints as well as marks collected from scenes of crime. This allows the police to search the records to find matches for crime-scene marks and to confirm the identity of anyone arrested.

Hardware includes fingerprint scanners, portable and handheld computers such as Personal Data Assistants (PDAs), printers and digital cameras for photos of suspects and crime scenes.

Driver licensing databases

By law, all drivers of vehicles on public roads must have a driving licence. A computerised driver licence system can issue driving licences and vehicle registration documents. Details on every driver and every vehicle can be kept on a massive computerised database involving millions of records. Apart from licensing drivers and vehicles, the database can be accessed by the police in their fight against crime.

If these millions of driver and vehicle records were paper-based, it could take minutes or hours to find the information required. By using a computer, the information can be found in seconds. Compared with paper-based systems, computer information systems are particularly impressive when carrying out searches across a number of different categories.

Recreation and entertainment

Game-playing is one of the most common uses of computer systems (Fig 4.14). Computer games have become a multi-million-dollar industry in the United States and software producers are constantly striving for new ideas for themes and concepts for their consumers. Computer hardware can be configured to suit game-playing specifications, with powerful graphics cards, amplified sound systems, high-resolution monitors and powerful CPUs. Game-playing consoles have also been created as dedicated game systems.

Virtual reality can also be used by game players. For example, some programs include a physical device that is attached to the computer, such as a tennis racket, to play a game with another user in the online world. Both players will be able to see the moving ball in real-time and use the actual racket to swing to 'hit' and feel the impact of the virtual ball on the monitor.

Fig 4.14 Virtual-reality helmets improve the experience in online games

Multimedia computers can play music CDs and DVD movies for entertainment. Many Internet users also download music and movies from the Internet. Software for playing CDs and DVDs is included with most multimedia computers, usually bundled with the latest operating systems. There are special players designed for storing and playing MP3 music files (Fig 4.15).

In the music industry, DJ controllers are used to blend different types of music. Along with music software programs, these devices include sound effects with the music using knobs, backlit buttons, touch strips and other components (Fig 4.16). They provide better control of the software containing the play list of songs than having to use a computer keyboard or laptop touchpad.

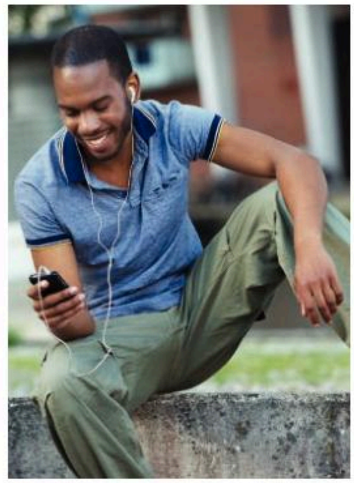


Fig 4.15 MP3 players are very popular for providing access to your downloaded music files while away from your computer

Fig 4.16 DJ Controllers are used to add sound effects to music

In the movie industry, computers have been used to create special effects in some movie scenes. There are also movies that have been made exclusively with computer graphics and animation. This requires the use of graphics workstations with powerful multi-core processors in order to process the data quickly and produce graphics of a high quality.

Questions

1. Name a device and explain how it is used to improve the monitoring of stock levels in businesses.
2. Name two services that are offered in online banking.
3. Name two applications of virtual reality.

Multiple choice questions

1 The exposure of a computer system to the possibility of theft or damage is called a(n):
- **a** attack
- **b** threat
- **c** vulnerability
- **d** countermeasure.

2 The computer-related professional who posts messages using Twitter and Facebook and sends mass emails to clients is a:
- **a** computer support specialist
- **b** social media specialist
- **c** systems administrator
- **d** web developer.

3 Place the following elements in the correct order to represent the stages in cybersecurity:
- **a** attack, countermeasure, vulnerability, threat
- **b** countermeasure, vulnerability, threat, attack
- **c** threat, attack, countermeasure, vulnerability
- **d** vulnerability, threat, attack, countermeasure

4 The use of websites or email messages to try to trick you into entering your personal information is known as:
- **a** propaganda
- **b** identity theft
- **c** financial abuse
- **d** phishing.

5 The use of technology to observe a user's actions, often without the user's knowledge, is known as:
- **a** unauthorised access
- **b** industrial espionage
- **c** computer surveillance
- **d** denial-of-service attack.

6 Using devices to monitor users' communications without their permission is called:
- **a** cyberbullying
- **b** computer surveillance
- **c** denial-of-service attack
- **d** electronic eavesdropping.

7 The following statements can be used to describe the three main types of viruses *except* that they:
- **a** are carried by a database file
- **b** do not require a host program
- **c** infect program files
- **d** infect system or boot files.

8 The use of computer systems to distribute potentially harmful information is called:
- **a** propaganda
- **b** cyber security
- **c** computer fraud
- **d** industrial espionage.

9 Preventing rightful owners of music from getting money due to them for their creative efforts is known as:
- **a** piracy
- **b** propaganda
- **c** cyberbullying
- **d** eavesdropping.

10 The best way to protect a computer against viruses is to *never*:
- **a** scan for viruses
- **b** open email attachments from unknown senders
- **c** turn on virus protection
- **d** install anti-virus software.

Short answer questions

11 Vanessa is working to complete a project on her new laptop to email to her supervisor.
- **a** Apart from a keyboard, list one other input device that Vanessa could use to help her complete the project.
- **b** Vanessa tried to email the document, but an error occurred each time she tried to attach it. Give one reason to explain a possible cause of the error.
- **c** Write an example of a suitable email address that is appropriate for Vanessa to use.
- **d** Vanessa decided to upload the document. Explain the term 'upload'.
- **e** State the name of the term that enables the project to be uploaded via the Internet.
- **f** Explain where the document could be stored once it has been uploaded.

g After four hours, Vanessa realised that the document was not uploaded. Explain, giving two possible explanations, why this might have occurred.

h Vanessa later realised that she could not access any of her programs that require a password. Discuss whether each of the following elements of cybersecurity occurred to her data:
  i a threat
  ii an attack
  iii vulnerable to a threat or attack.

i Vanessa thinks she should call a computer professional to help her with the laptop. What is the general name given to this professional?

12 Cameron is taking an online course in August, which happens to be during the hurricane season.

a Suggest one hardware device that he should have in case of a power outage.

b His lectures are located on a special course page where only students have access to the course notes. Describe the type of network that provides this level of privacy.

c On the course page, Cameron clicks on the name of a topic which opens another web page. Describe the special connection that caused this action.

d Cameron receives an email stating that the website has been impacted by a 'denial-of-service' attack.
  i Explain what is meant by this term.
  ii Describe two examples which explain that such as attack has occurred.
  iii State the computer-related professional who may be able to resolve the problem.

e Cameron has been working for over six hours on an assignment. He is relaxing on the floor using his laptop. He has lots of articles around him and types while occasionally glancing at the television.
  i Explain how Cameron's body can be negatively affected by working in this way.
  ii He has quoted information in his assignment from two of the articles but has not included the names of the authors or the articles. Describe the term that explains Cameron's actions, and discuss whether or not it is appropriate for a school assignment.

5.1 Introduction to word processing

Word processing on a computer is simple. You start to type your text, typically using a keyboard. At the end of the first line the cursor will automatically move down to the next line. This feature is called word-wrap, and it means you cannot make a line that is too long. If you make a spelling error as you type, you do not have to correct it immediately. Some word processors will underline typing or grammatical errors for your attention, but you can position the cursor with a mouse or cursor keys to delete or add letters, words, phrases, sentences or paragraphs – however much text you want to change. Also, you do not need to type the entire document at once, because you can save your work and return to it later – either to continue or to make changes. Documents can also be emailed or downloaded from online storage (Fig 5.1). Making your words look good is straightforward, too. Unlike a typewriter, you can have different styles and sizes of the **typeface** in your document.

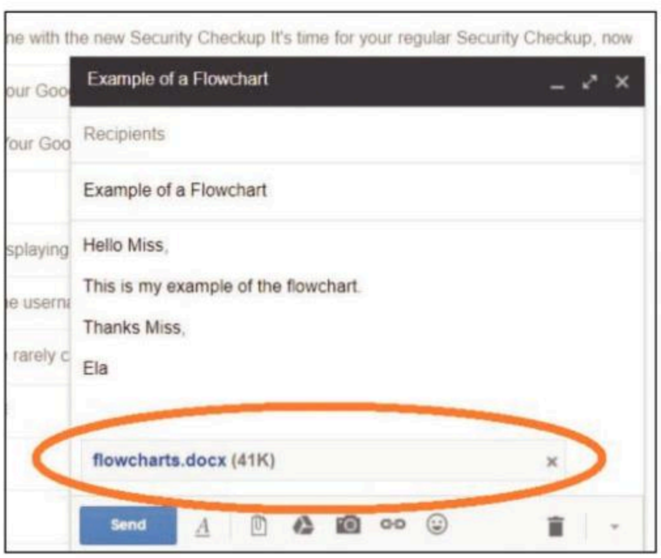


Fig 5.1 Word-processed documents can be emailed

Before you improve the look of your document, you should know how to start with a blank document, open one already created and save your file with a new name.

When you first launch a word-processing application, you can begin to type using a blank document. You can also open an existing file to a new document window or switch from a current document to a new screen without having to close any documents.

Key features

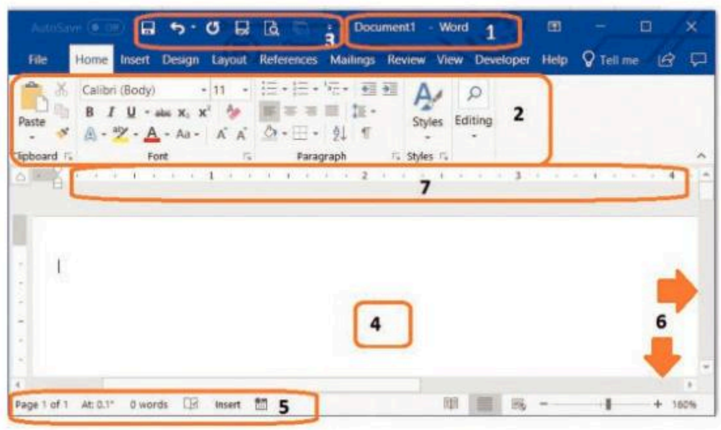


Fig 5.2 shows some of the features when working with a document

1 *Title bar:* This indicates which application you are presently using and shows the name of the document at the top of the screen. When you create a new document, the name of that document will be 'Document 1', for example.

2 *Ribbon:* This is shown in recent versions of Microsoft Word. It replaces the Menu bar found on earlier versions It contains the **menu** of *commands* used to **format** your document. It has multiple tabs with groups of similar commands. Most of the

Standard toolbar and Menu bar items from earlier versions now appear on the Home tab.

3 *Quick Access Toolbar:* This toolbar shows commonly used commands such as **Save**, **Undo** and **Redo**.
4 *Input screen:* The input screen is the part of your screen where you type your document text.
5 *Status bar:* The status bar displays information such as the document's page and word count.
6 *Scroll bars:* Scroll bars are used to scroll the page on the screen, such as upwards, downwards or from left to right.
7 *Ruler:* The ruler displays the measurements, indents and tabs of your document.

As you prepare a document, it is important to understand the layout of the page. This includes the margins, paper size, paper source and orientation of the page.

Margins

It is usual to see a small gap between the text on a page and the edge of the page. This gap is called a margin. **Margins** are typically 1 inch from the edge. Leaving a margin is especially important when you need to bind a document together. It is also useful when you want to add a page number or a heading that prints on each page. More importantly, most printers cannot print right to the edge of the page. You can normally select the size of the top, bottom, left and right margins or type each one separately by typing in the distance from the edge of the page to the text.

Paper size

You can select different sizes of paper on which to prepare your document. The size of paper affects the page length and width of the workspace. Typical sizes are letter size ($8\frac{1}{2}$" × 11"), A4 (210 × 297 mm) and legal size ($8\frac{1}{2}$" × 14").

Orientation

Documents are in one of two orientations, which are usually known as **portrait** and **landscape** (Fig 5.4).

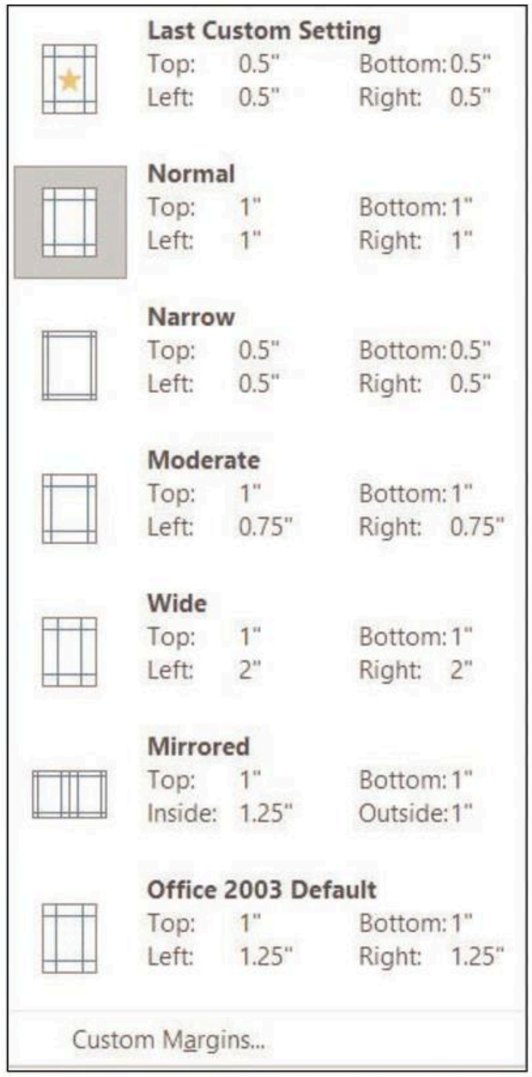


Fig 5.3 Margins can be customised for each document

Sometimes portrait is known as tall and landscape is known as wide.

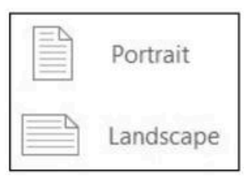


Fig 5.4 Portrait and landscape orientation

Editing text

Once you have entered your text you can easily edit it. This means that you can correct mistakes before presentation of the final document. Most of the time you may have to select more than one word, or sentence, paragraph or page. You can select a block of text by using the mouse or the cursor keys. When a block of text has been highlighted, it can be edited: the font, style, size and alignment of the block of text can be changed.

There are three main ways of editing text:

- adding, deleting and retyping text
- moving, copying and pasting text
- searching for and replacing text.

Adding, deleting and retyping text

To add or delete text, place the cursor at the desired location and click the left mouse button once. To insert text, start typing! The existing text will move to the right to accommodate the new text. To delete text, press the *Delete* or *Backspace* key. The *Delete* key will delete all text to the right of the cursor while the *Backspace* key will delete text to the left of the cursor. You can create blank lines by pressing the *Enter* key.

Moving and copying text

It is also possible to delete part of your text such as words, sentences or paragraphs, and replace that part with new text.

First select the text you wish to delete, and then start typing. The selected text will disappear and be replaced by whatever new text you type. An alternative is type-over mode, which causes any text to the right of the cursor to be replaced or 'typed over' as you type. The *Insert* key on the keyboard toggles between insert and type-over mode. OVR appears in the status bar at the bottom left side of the application when the type-over mode is active.

A third way to select text is to place the cursor at the beginning of the required text. Select the text by pressing and holding down the left mouse button and dragging the mouse across the text to be selected, releasing the mouse button at the end of the selection.

A quicker way to select a word or a block of text is to perform block operations.

Performing block operations

- To select a word, double-click on it.
- To select a sentence or paragraph, triple-click on a word in it.
- To select a block of text, click at the beginning, hold the *Shift* key and click at the end.
- To select the entire document, hold down the *Ctrl* key and press *A* (for All).

The basic copy, cut and paste operations work the same way in most Windows applications. Text that is copied or cut is placed in a temporary storage place called the clipboard.

To move text, you must 'cut' or remove the text from where it is and 'paste' it in its new location. To do this, select the text and then click the **Cut** icon on the Standard toolbar, Edit menu or Home tab of the ribbon (you may also use *Ctrl* + *X* on the keyboard). The text disappears and moves to the clipboard. Click the mouse pointer or use your cursor keys to where you want to move the text and then click the **Paste** icon or press *Ctrl* + *V*. The text moves to the new location.

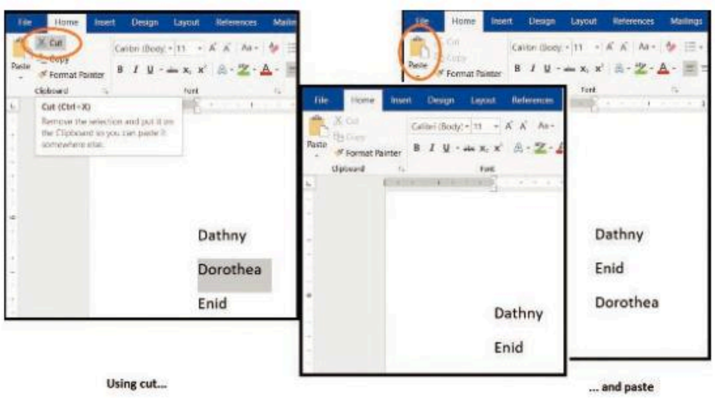


Fig 5.5 Using cut and paste

A similar process is used for copying. First select the text and then click the **Copy** icon (or use *Ctrl* + *C*). The text stays where it is but the word processor keeps a copy in the clipboard. Move the cursor to where the text will be inserted, and paste it. The text appears in both places.

Sometimes as you are typing, it is easier to use keyboard commands to move to another part of the document. Table 5.1 shows some of the commands you can use to move the cursor.

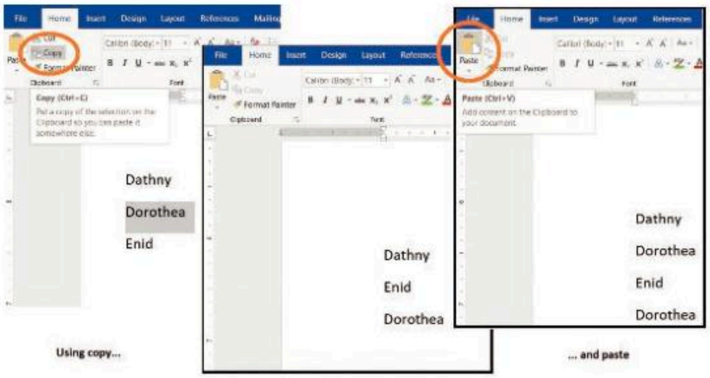


Fig 5.6 Using copy and paste

Table 5.1 *Keyboard commands used to move the cursor*

<Ctrl><left arrow>	Move to previous word
<Ctrl><right arrow>	Move to next word
<Ctrl><up arrow>	Move to previous paragraph
<Ctrl><down arrow>	Move to next paragraph
<Home>	Move to beginning of line
<End>	Move to end of line
<PgUp>	Move to previous screen
<PgDn>	Move to next screen
<Ctrl><PgUp>	Move to top left of screen
<Ctrl><PgDn>	Move to bottom right of screen
<Alt><Ctrl><PgUp>	Move to beginning of text on screen
<Alt><Ctrl><PgDn>	Move to end of text on screen
<Ctrl><Home>	Move to beginning of document

The Undo and Redo commands

If you make a drastic change in your document that you did not intend (like accidentally deleting a whole page), don't panic! As in most Windows applications, you have a chance to retrieve your last action by clicking the **Undo** icon or using the *Ctrl* + *Z* keyboard combination. Certain changes may not be reversible, but your word processor will often warn you of this beforehand. If you clicked the Undo icon, and you wish that you had not undone your last action, you can click on the **Redo** icon. Many word processors allow you to do multiple Undos and Redos.

Save vs. save as

Under **File** on the Menu bar are options of **Save** and **Save As**. If you are working in a new document and you select Save, your word processor asks you for a filename. If you are working in a previously saved document and select Save, the word processor, without warning you, saves the newer version to replace the older version of the document. The older version is lost. If you select Save As from the File menu, then you can give the document a new filename or save it in a new location. You will then have both old and new versions saved.

Fonts

A **font** is a style of writing. Modern word processors are supplied with a wide range of fonts for you to choose from. Different fonts are useful for different purposes. For example, plain fonts such as Arial and Times New Roman are good for writing letters and reports.

Fig 5.7 Different fonts are useful for different purposes

Font size

Most fonts are scalable, which means that they can be as big or as small as required. The size of a font is specified by a number known as the *font size*. Sizes 10 and 12 are the most common for writing letters and reports. Font sizes are specified in 1/72ths of an inch. So fonts at size 72 are one inch tall and fonts at size 36 are half an inch tall.

Fig 5.8 Font sizes

Font style

Each font can have a range of extra styles applied to it. The six common styles are:

- Normal: no special style is applied to the font.
- Italic: the font will be displayed as if it is leaning slightly to the right.
- Bold: the lines used to draw the font will be drawn extra thick to make the text stand out.
- Underline: a line will be drawn underneath the text.
- Superscript: the text is raised up to the top of the line and printed at a smaller size.
- Subscript: the text is lowered to just below the line and printed at a smaller size.

Normal Style	*Italic Style*	**Bold Style**
Underline Style	superscript style	subscript style

Fig 5.9 Examples of font styles

Alignment

Alignment describes the position at which text appears on a line on the page. Alignment is sometimes known as justification. There are four different types of alignment: left, right, centre and fully justified, as shown in Figure 5.10.

This is an example of text that is left aligned on the page.

This is an example of text that is right aligned on the page.

This is an example of text that is centred on the page between the left and right margins.

This is an example of text that is fully justified on the page between the left and right margins.

Fig. 5.10 Alignment of text

Working with tabs

Tabs enable you to align your text to the left, right, centre or full justification, or align to a decimal point. You can also automatically insert specific characters, such as periods or dashes, before the tabs.

The ruler shows where tabs are located on your document. Click View, Ruler to show the ruler at the top of the page and to see any tabs (Fig 5.11). In later versions of Microsoft Word, click on the ruler to insert tab stops. In earlier versions (like 2007) you can select the *Page Layout* tab from the menu to reveal the tab stops dialogue box.

A tab position is the distance of the tab location from the left margin on the line. You can choose the desired alignment by clicking the leftmost edge of the ruler as shown by the arrow in Figure 5.11. The different tabs are shown as you click. Then set the tab by clicking on a location on the ruler. You can place more than one tab on the ruler or drag the tab to move it to another location on the ruler.

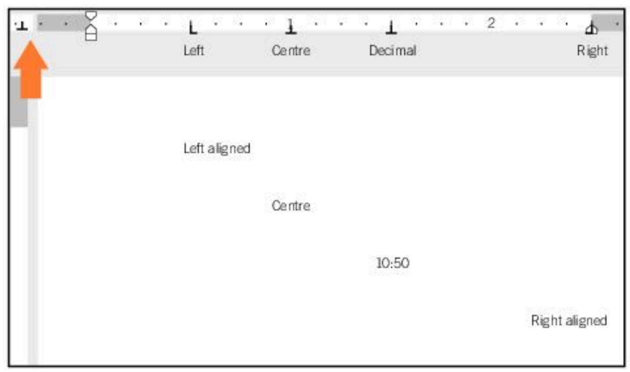


Fig 5.11 Four types of tabs

Format Painter

Sometimes you may have formatted one part of the document and would like the same formatting on another part. You may have noticed the 'paintbrush' button on the Standard toolbar Format Painter. This button is called *Format Painter*, and it is a very useful button. Format Painter copies character or paragraph formatting from one place to another within a document.

To copy paragraph formatting:

1. Select the text.
2. Click the paintbrush button and then paint (drag across) the text that you want to apply the formatting to.

If you double-click the Format Painter button it becomes a toggle so that you can paint the new formatting to several paragraphs.

3 Double-click within the paragraph where you want to copy the formatting.
4 Click the Format Painter button.
5 Select the paragraph or text that should be reformatted to look like the first paragraph.
6 If you have activated the Format Painter in this way, press *Esc* when you're finished and your mouse will return to normal.

Paragraph formatting

With today's word processors, it is possible to control precisely the amount of space between paragraphs. There is no longer any need for the old typewriter style of pressing the *Enter* key twice to separate paragraphs.

Line spacing

The space between the lines, also called **line spacing**, can be changed in the whole document or in a specific block of text. You can also determine the line spacing before typing your text. If you do, the line spacing you choose will be applied to all text you type until you select another line spacing value. Also, once text has been typed, you can select a text block or part of the document and select the line spacing you wish. Table 5.2 shows some typical line spacing and their keyboard shortcuts.

Table 5.2 *Types of line spacing*

Single	Inserts a line spacing a little larger than the size of a character	*Ctrl* + 1 formats text as single spacing
1.5 Lines	Inserts a line spacing equivalent to one-and-a-half times the size of a character	*Ctrl* + 5 formats text as one-and-a-half spacing
Double	Determines a line spacing twice the size of a character	*Ctrl* + 2 formats text as double spacing

Indenting

An indented word or paragraph is set at a distance away from the margin (left or right). A word may be indented from the left margin simply by placing the cursor to the left of the word and pressing the *Tab* key.

To *indent* a paragraph, select the paragraph to be indented. Click the indent icon : Left for indentation from the left margin or Right for indentation from the right margin.

Page numbering

Pages in your document should be numbered to keep them in order. Note that page numbering may also be added in the header or footer section of the document.

You can number the pages like this:

1 Click Insert.
2 Click Page Number.
3 Select the Position (top or bottom) and the alignment on the page (left, right, centre).
4 Click the Format button.
5 Use the dialogue box (Fig 5.12) to adjust how your page numbers appear, the number from which they start if page numbering does not start from the first page.
6 Click OK to return to the page.

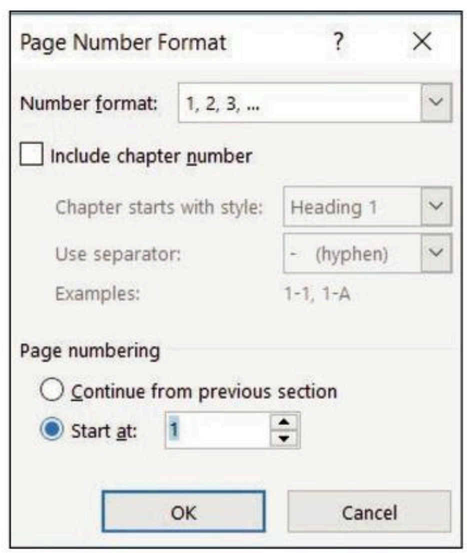


Fig 5.12 The Page Number Format dialogue box

Find and Replace

The **Find and Replace** function (often called Search and Replace) will first look (search) through the document to find one or more words that you specify. Once the word is found, the computer can automatically replace it with another word that you type in. This is usually the *Replace All* option. Alternatively, you can use another option simply called Replace. This asks you to approve each replacement. This is safer because you may not want to make the change everywhere.

If you start your search somewhere in your document, a dialogue box will pop up confirming whether you wish to continue the search from the start of the document.

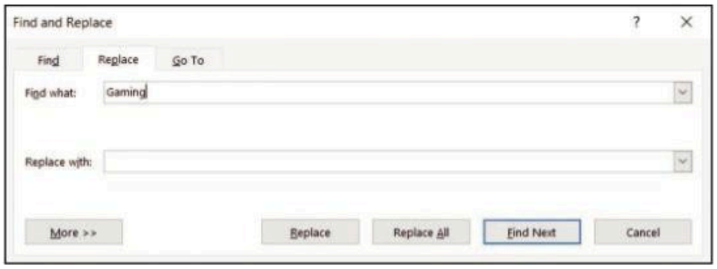


Fig 5.13 The Find and Replace dialogue box

Questions

1. Explain the difference between:
   - **a** Open and New
   - **b** Save and Save As.
2. What do you understand by 'selecting' text?
3. You have two paragraphs of text typed, which you want to edit. How many paragraphs would you have if you:
   - **a** copied and pasted paragraph 2
   - **b** cut paragraph 1
   - **c** clicked Undo
   - **d** clicked Redo
   - **e** clicked Copy.
4. State the keyboard combinations used to create single, double and one-and-a-half line spacing.
5. Describe the benefits of using the Format Painter.
6. Explain one advantage and one disadvantage of using the Replace All option.

Practical exercises using Microsoft Word

Exercise 1: Selecting text

1. Open a blank Word document.
2. Type the following text: It was 5am on Saturday morning. She was at the airport waiting to come home.
3. Double-click on the word 'morning'.
4. Triple-click on the text. Click on the Copy icon, and paste the text three times.
5. Click at the beginning of the first sentence, hold the *Shift* key and click at the end of the first paragraph to select a block of text.
6. Hold down the *Ctrl* key and press *A* (for All) to select all the text in the document.

Exercise 2: Block operations

1. Type the following:
   Workshop (press *Enter*)
   Travel (press *Enter*)
   Script (press *Enter*)
   Education (press *Enter*)
2. Use the block operations or cut, copy and paste options to move the text into alphabetical order – Education, Script, Travel, Workshop.

Exercise 3: Find and Replace

1. Type the following text:
   When you click Online Video, you can paste in the embed code for the video you want to add. You can also type a keyword to search online for the video that best fits your document.
2. Use the Find and Replace function to change all occurrences of the word 'video' to 'recording'.
3. Format the text to double spacing.
4. Create an indent for the first line of the paragraph.
5. Insert page numbering centred at the top of the page.

Headers and footers

Suppose you want to place a heading or logo at the top of each page of your document, or maybe a page number at the bottom of all the pages of the document. Text which appears at the top of each page but inside the top margin, is known as a **header**. Text which appears at the bottom of each page is known as a **footer**.

In Microsoft Word, the header is shown within the broken lines. Any text typed in this section, will automatically appear in a similar position on all subsequent pages. A footer is similar, except that it is placed at the bottom of each page (Fig 5.14).

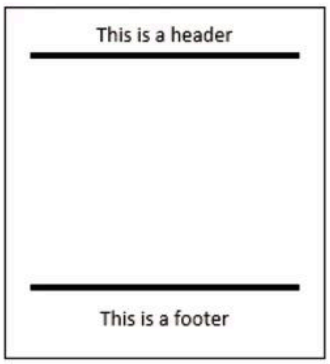


Fig 5.14 A header and footer

The Header and Footer toolbar, or Design tab on the ribbon when the header or footer areas are active, provide the tools you need to format the top and bottom margins in a document. You can use the same header and footer throughout a document or change it for part of the document. For example, you can use a graphic in the first-page header, and then include the document's file name in the header for the following pages. Many word processors will also let you type special codes which will automatically insert information such as the current date or current page number into the header or footer of a document.

Footnotes and endnotes

Footnotes and endnotes have many uses, ranging from supplying extra information about a topic within the body of the text to providing a reference for a quotation used in the text. A **footnote** or **endnote** is made up of two parts: a reference number in the text and the actual entry at the bottom of the page or at the end of the chapter or text. Using auto-numbered footnotes or endnotes allows you to delete, insert and rearrange your footnotes or endnotes without having to worry about the numbering. Footnotes are usually placed after a separator line at the bottom of the page that contains the footnote reference number. Endnotes are placed together at the end of a section or the entire document.

Section breaks

To understand how a section break works, think of your document as a book with different chapters or sections. A *section break* is a mark inserted to show the end of a specific part of a document, and the end of the formatting that is applied to that section. This mark stores the section formatting such as page orientation, margins, headers and footers or sequencing of page numbers. The mark appears as a double dotted line with the name of the kind of section break in the centre. In a word processor such as Microsoft Word there are four types of section breaks:

- Continuous: inserts a break and starts the next section on the same page
- Next Page: inserts a section as well as a page break and starts the next section on the next page
- Odd: inserts a section break and starts the new section on an odd page
- Even: inserts a section break and starts the new section on an even page.

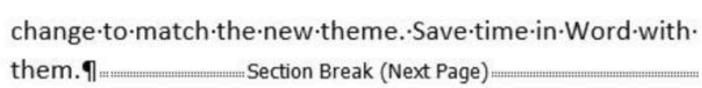


Fig 5.15 Section break in Microsoft Word

Section breaks therefore allow you to specify where the different formatting will begin and end. You might use section breaks in the following situations:

- different headers and footers: if the document you are working on needs to have different headers and footers on various pages
- different numbering schemes: if you are working in a document where the table of contents needs different numbering such as letters, numbers and Roman numerals
- different paper sizes: if you want a document to contain portrait pages for text and landscape pages for tables and charts
- different margins: if the first page of a letter needs a two-inch margin, and the following pages need a different margin
- columns: you can use your word processor's newspaper column feature in the middle of a page, and place section breaks before and after the multiple columns. If you have text prepared and put it into a column format, your word processor will automatically put in the section breaks.

Questions

1. What is a section break?
2. You have a document that contains sections breaks. State whether odd section breaks or even section breaks would have been applied to pages 17, 22 and 35.
3. Give two situations where the use of sections would be appropriate.
4. Describe an example of how a footnote is used in a word-processing document.
5. What are the similarities and differences between footers and footnotes?

Practical exercises using Microsoft Word

Exercise 4: Headers and footers

1. Navigate to the Header and Footer icons (View or Insert in different versions of Microsoft Word).
2. Select Header to insert a header at the top right of the page.
3. Type 'Practical exercise using a header'.
4. Move your cursor to the bottom of the page below the dotted lines to view the footer. There should be no text in that section.
5. Click the Insert Page Number icon.
6. Click the Date/Time icon to insert the date.
7. Click Close on the Header and Footer toolbar or double click on the main part of the document.
8. You should see the added information on your page. Alternatively, switch to Print Preview to view your newly added header and footer.

Exercise 5: Footnotes and endnotes

1. Type the sentence 'This is a footnote, not a footer.'
2. Navigate to the References tab and select Footnote (this option may be different in previous versions of Word).
3. Select the Footnote option. The cursor moves to the bottom of the page. Type 'Example of a footnote.' You have just created a footnote.

Creating tables

A table is a convenient way of grouping text in an organised manner. It is constructed of cells grouped in rows and columns. The height, width and borders of these rows and columns can also be changed. Cells can be merged (joined together) or split. The table below shows a list of owners and the names and ages of their pets.

Owner	Pet	Age (years)
Rashid	Turtle	2
Jurnee	Dog	4
Jana	Bird	1

The table feature allows you to select the number of rows and columns needed. In an existing table, one or more rows can be added above or below the selected row, while one or more columns can be added to the left or right of the current column. Rows and columns can also be deleted, and cells in the table can also be added or deleted to shift data in the table up, down, to the left or right of the current cell. This is achieved by placing the cursor in a cell in the table and then right-clicking to show the various table options.

The design and layout of a table can be modified by changing the type of border, the style of the lines and the thickness of the lines in and around your table. Rows, columns or cells can also be shaded in different colours.

You can also apply limited summation and other functions to a table in a word-processing document, although this is not intended to replace the Excel spreadsheet. While tables have replaced the old method of using the *Tab* key to align data in columns, sometimes you may need to convert some tabbed data into a table. The *Convert Text to Table* option achieves this, once the data is separated by tabs, commas, paragraphs or a single specific character (Fig 5.16).

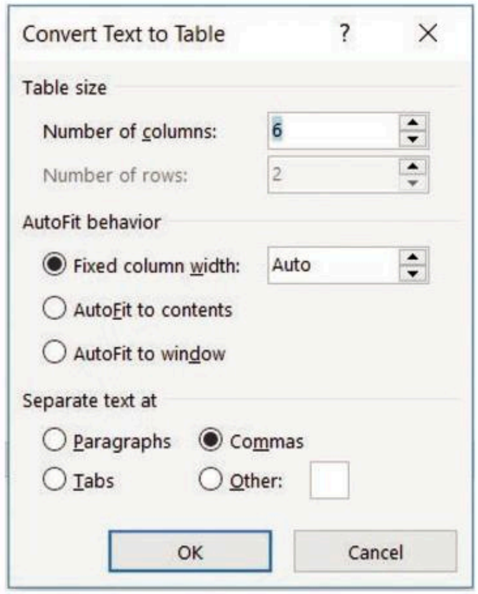


Fig 5.16 Converting text to a table

Creating columns

You can divide a page up into several parallel columns. This is particularly useful if you want to produce a newspaper, newsletter or a leaflet which could be folded. Laying out text in two or more columns saves space on the page.

The column feature can be created in the middle of a page. With column section breaks placed in a column format (Fig 5.18). Word will automatically put in the column section breaks. Note that a column break is used to stop text at the end of one column and continue it in the next column.

Questions

1. Describe one example of using a table in a word processor.
2. Explain the difference between adding a column and adding a row to a table.
3. State the number of rows and columns in the table shown in Figure 5.17.

Example of a table		
Type	Name	Example
Fish	Small	Flying
Fruit	Seeds	Cherries

Fig 5.17 Example of a table

Video provides a powerful way to help you prove your point. When you click Online Video, you can paste in the embed code for the video you want to add. You can also type a keyword to search online for the video that best fits your document.

To make your document look professionally produced, Word provides header, footer, cover page, and text box designs that complement each other. For example, you can add a matching cover page, header, and sidebar. Click Insert and then choose the elements you want from the different galleries.

Video provides a powerful way to help you prove your point. When you click Online Video, you can paste in the embed code for the video you want to add. You can also type a keyword to search online for the video that best fits your document.

To make your document look professionally produced, Word provides header, footer, cover page, and text box designs that complement each other. For example, you can add a matching cover page, header, and sidebar. Click Insert and then choose the elements you want from the different galleries.

Themes and styles also help keep your document coordinated. When you click Design and choose a new Theme, the pictures, charts, and SmartArt graphics change to match your new theme. When you apply styles, your headings change to match the new theme.

Save time in Word with new buttons that show up where you need them. To change the way a picture fits in your document, click it and a button for layout options appears next to it. When you work on a table, click where you want to add a row or a column, and then click the plus sign.

Video provides a powerful way to help you prove your point. When you click Online Video, you can paste in the embed code for the video you want to add. You can also type a keyword to search online for the video that best fits your document. To make your document look professionally produced, Word

Fig. 5.18 The column feature can be used in the middle of your text

Practical exercises using Microsoft Word

Exercise 6: Creating tables

A Create the table

1 Navigate to the Insert Table feature. Insert six columns and five rows.

2 Type the text in the table as shown.

First name	Last name	Company	Fees	Mem-bers	Group #
Mala	Tuim	Gaming Inc.	$250	5	4
Clavery	Lotte	Team ALL	$300	7	2
Alison	Zacton	N-Ta-Tane	$175	3	3
Ross	Allen	Master Gamers	$300	8	3

3 Save the document as 'Competition'.

B Change the width of the table columns

1 Make sure no part of the table is selected.

2 Move the mouse pointer to one of the vertical lines in the table until it changes shape to two arrows pointing left and right, with a pair of parallel lines between them.

3 Click and drag the mouse to move the gridlines to increase or decrease the width of the columns or the rows. Alternatively, some applications allow you to double-click to adjust the width of a column.

C Sort the table

1 Select the whole table and choose the Sort icon .
2 Check that option Header Row is clicked. Sort the table by Last name in Ascending order.
3 Click OK to sort the table.
4 By selecting Header Row in the Sort dialogue box, the header row (titles) will not be sorted with the rest of the rows.

D Insert a row and add a formula

1 Place the cursor in the last cell in the Group # column. Press *Tab*. A new row will appear at the bottom of the table.
2 In the first cell of the new row, type 'Totals'. Press *Tab* to go to the Fees column.
3 Select the Design menu option from the Table tools and select the Formula icon. Check that =SUM(ABOVE) is entered in the Formula dialogue box and click on OK. Repeat for the sum of the Members column.
4 Press *Tab* to go to the Group # column. Select the Formula icon. This time change =SUM(ABOVE) to =COUNT(ABOVE) in the Formula dialogue box and click on OK.

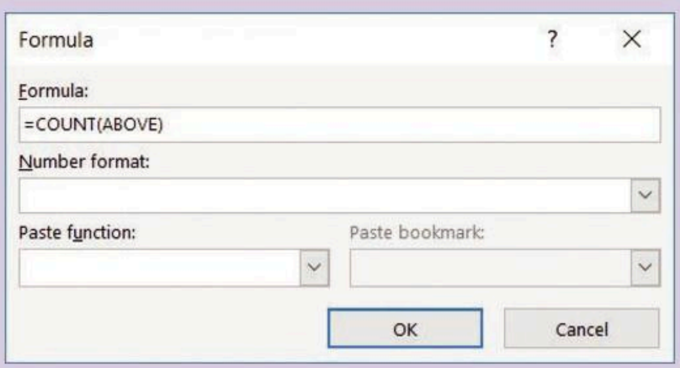


Fig 5.19 Add a formula to a table

E Change one of the Group # figures

1 Change the group number for Alison from 3 to 1.
2 Double-click on total for the Group #, using the right mouse button, select Update Field to see the result. Save the file as 'Table Exercise'.

F Merging and splitting cells

1 Place the cursor in a cell in the first row with the headings. Right-click and select the Insert option. Select *Insert rows above* to insert a new row above the headings of the table.
2 To merge all cells of the new row into one, highlight all the cells, right-click and select Merge cells from the Table menu.
3 Type 'Registration for Gaming Competition'.
4 Centre the heading.
5 Note that once a cell is highlighted it can be split by right-clicking in the row and choosing Split cells from the Table menu. The dialogue box that appears will allow you to choose the resulting number of columns and rows.

Exercise 7: Columns

1 Open a blank word-processing document.
2 Type '=rand(6,3)' (without the quotes) and press *Enter*. Alternatively, type 'Video provides a powerful way to help you prove your point.' Copy the sentence and paste it three times. Copy the paragraph of three sentences, press *Enter* twice and paste the paragraph five more times, pressing *Enter* between each paragraph.
3 Select the first three paragraphs.
4 Navigate to the Columns icon. In recent versions of Microsoft Word, it is found in the Layout tab on the ribbon.
5 The Columns option box is displayed as shown in Figure 5.20.

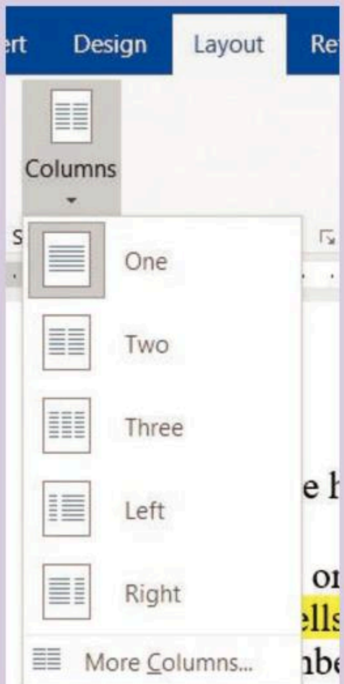


Fig 5.20 Creating columns

6 Select Two columns.
7 The selected paragraphs will be subdivided into two columns. If there isn't enough information for two columns, it will fill the left column only.
8 The document remains the same, except that text reads down the left half of the page and continues on the right half.
9 Select the fourth and fifth paragraphs. Use the Columns option to create three columns.

Exercise 8: Using column breaks

The column break is used only for subdividing text between columns.

1 Place the cursor at the beginning of the fourth paragraph. The cursor should be at the leftmost column.
2 From the menu, select Insert, Break or, in recent versions of Microsoft Word, select the Layout tab on the ribbon, select Breaks.
3 From the list, select Column Break.

The text moves and now starts from the second column.

Exercise 9: Unequal columns

With a column layout, it is possible to set unequal sizes for each column.

1 Place the cursor in the left column at the start of paragraph 1. Click on the Columns option and select More columns (in earlier versions, untick Equal column width).
2 Choose the Left column setting which makes the left column narrow and gives the right column more width.
3 Maintain the spacing between the columns as 0.5". Select OK.

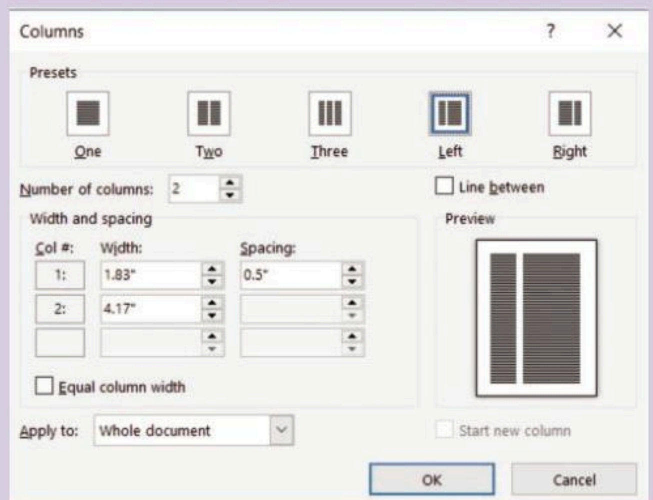


Fig 5.21 Formatting text with uneven columns

Before you print or share your document with others, it is best to proofread it for spelling and grammatical errors. You may also want to make comments that will be useful later or for others to read when you share the document. Other features such as Word Count and **Track Changes** (knowing what has been edited by yourself or others) are useful options when reviewing your work.

Just as you would cross out, circle or make a comment in a paper-based document, as well as check for errors, word processors can easily perform these functions for you.

Proofing language

Before you begin to review your document for spelling errors, you may want to confirm the language that you will use to proofread your work. For example, UK English recognises the spelling of words containing 's' and 'z' differently from US English. The language option also confirms whether you wish to have the document checked for errors in spelling or grammar.

Spellcheck

A **spellchecker** will examine your text and identify any spelling mistakes. When a mistake is found most spelling checkers will attempt to 'guess' what the correct word should be and make some suggestions to you. You can accept one of the suggestions or retype the word correctly yourself.

Spellcheckers have quite large dictionaries with thousands of words that are supplied with the word processor. However, there will be some words that are not in the dictionary, such as people's names. You can usually add extra words to the **dictionary**.

A spellcheck cannot spot mistakes where you have typed the wrong word. For example, it will not spot 'their' instead of 'there' or 'the' instead of 'they'.

Your word processor starts spellchecking from the cursor position and checks to the end of the document. When the spellchecker reaches the end of the document, a dialogue box opens, asking if you want to continue spellchecking from the beginning of the document. Spellchecks also find repeated words.

The Spelling icon in the *Proofing* group provides options for handling errors. You can select a range of text and then click the *Spelling* icon to spellcheck only that block of text.

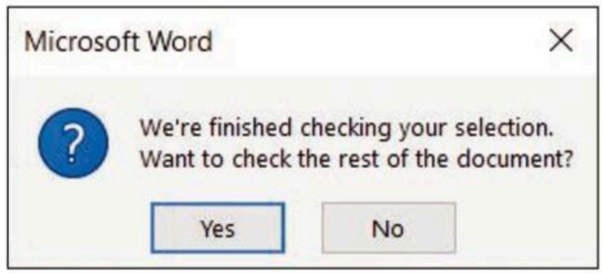


Fig 5.22 Spellcheckers can review an entire document or sections of it

Spellcheck options

Here is a list of the options available in the spellcheck dialogue box, with their meanings:

- Ignore Once: ignore word just this one time
- Ignore All: ignore every one of the selected words
- Add to Dictionary: if a word you type is not in the computer's dictionary it can be added
- Delete: delete a word if it occurs only once
- Change All: change all occurrences of a highlighted word
- AutoCorrect: the computer will automatically correct this word every time it occurs
- Options: gives you many choices, such as changing the dictionary language, ignoring uppercase letters and words with numbers.

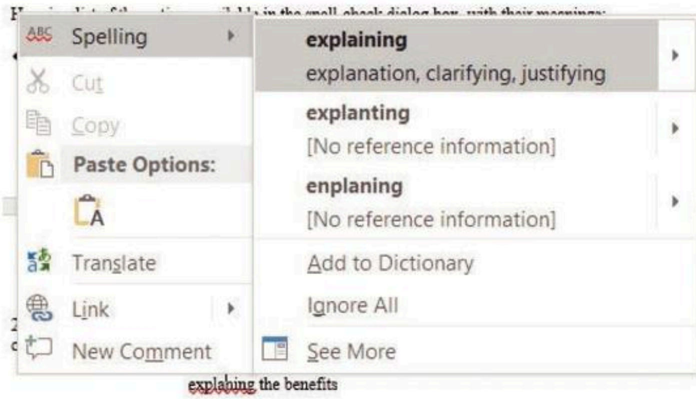


Fig 5.23 There are options when correcting an error

Thesaurus and grammar check

Most word processors also offer thesaurus or grammar check features. This is different from a spellcheck.

A thesaurus will suggest alternative words with the same meaning as a word that you have typed in (synonyms). For example, if you type 'big' the thesaurus might suggest 'large', 'huge' and 'vast'.

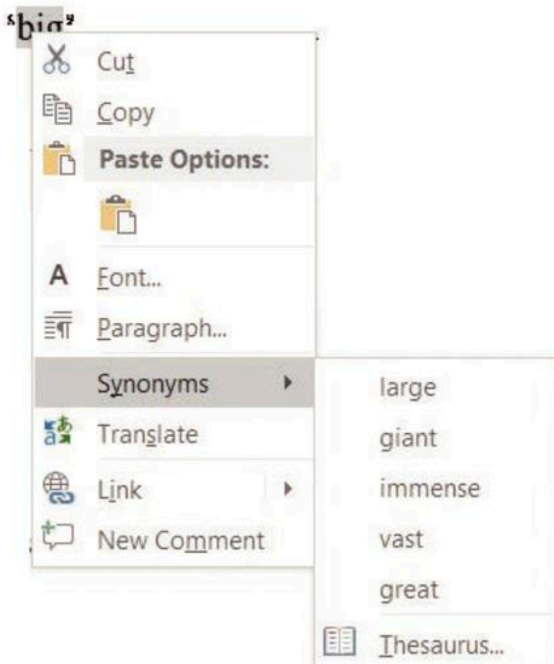


Fig 5.24 A thesaurus will suggest alternative words with the same meaning

A grammar checker will examine the structure of any text you have typed and may highlight some grammatical errors.

Word Count

The status bar at the lower left of a word-processing document provides a summary of the number of words in the document. However, for a more detailed summary, the Word Count option in the Proofing Group of icons shows the number of pages, words, lines and characters in the document.

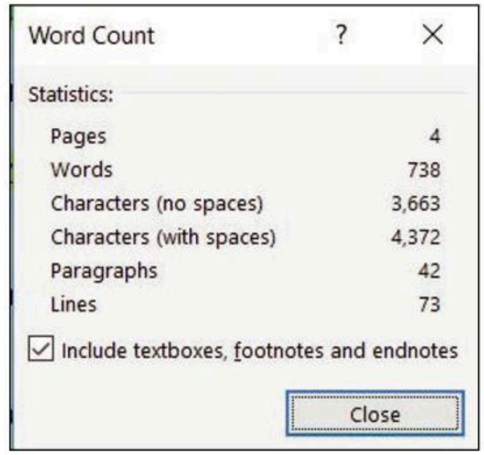


Fig 5.25 The Word Count feature summarises the number of pages, words, characters, paragraphs and lines in the document

Tracking changes in your document

The Tracking feature is a useful way to monitor any editing that you make to a document. When this feature is used, every edit to the document is highlighted. As you delete text, it will usually change to a colour such as red with the text crossed out. As you insert text, it also will be typed in a colour but will be underlined. The Changes feature is used to review each edit in the document so that you can accept your changes or reject them and retain the original text.

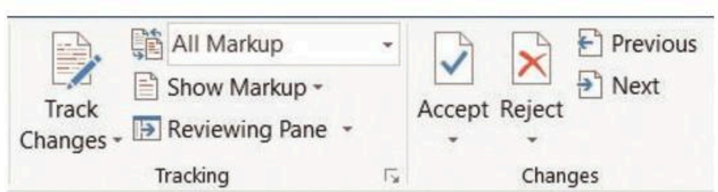


Fig 5.26 Sometimes it is useful to track any editing in a document

Comments

Adding **comments** is an alternative to editing a document directly or using Track Changes. It is also useful if you are reviewing a document for someone where the content is not being changed in any way. A comment can be created by placing the cursor near the text, then right-click and select New Comment. An alternative method is to use the Review tab to add and delete comments (Fig 5.27). Once more than one comment has been added to the document, each can be selected and responded to, or all comments can be viewed.

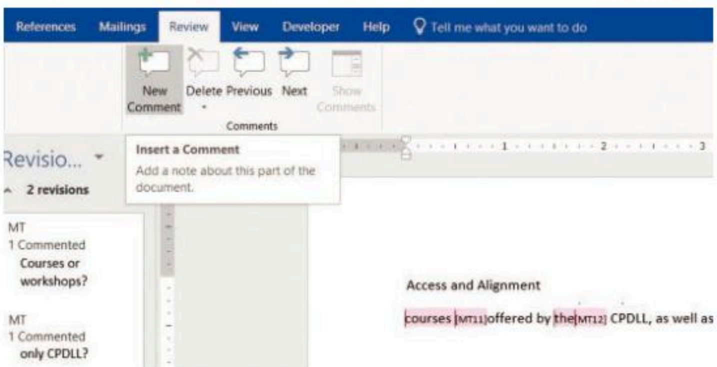


Fig 5.27 Comments can be inserted in a document using the icon in the Review tab on the ribbon

Protecting a document

There may be times when you make changes to a document and then save it, only to realise that you need the original text. Most word processors have an AutoSave feature that automatically saves your work every few minutes. So, if your original document is located on a secondary storage device, it will update the file in that location with the latest changes as you make them.

The Save As feature can also be used to avoid saving a document and overwriting previous edits. If you have made major changes to a document, use the Save As option to create a copy of the updated document. You can update the name of the document to include, say, 'version1', 'version2' and so on, or use the current date in the file name so that you have multiple versions as a backup until your document is finished.

Occasionally you may want to protect a document if you are sharing it with others. If no changes are to be made, the document can be saved as read-only or marked as final. A password can also be used if it is to be accessed by selected persons. Just ensure that you do not share the password in the same email, for example, as the password-protected document.

Users who have access to a document could also have specific restrictions placed on it. This includes preventing formatting changes, track changes, comments, general editing, copying or even printing the document. A higher level of protection involves the use of a *digital signature* to confirm that the document accessed is valid and has not be modified. A digital signature can include a scan of a signature or other information that confirms the validity of the document.

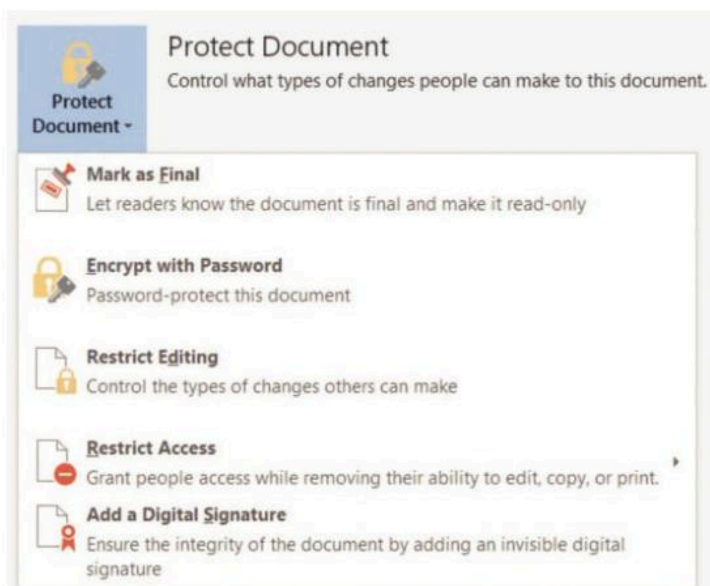


Fig 5.28 Documents can be protected using different options

Questions

1. You have typed a document using a word processor. State the most appropriate feature for each of the following descriptions:
   - **a** will ***not*** detect whether 'the', 'their' or 'there' was used correctly
   - **b** will leave a deleted phrase in the document, but with a ~~line through~~ the text
   - **c** allows you to leave a note for a user's attention
   - **d** a method to check the amount of text within a specific limit.
2. Explain the difference between a spellchecker and a thesaurus.
3. List three ways in which a document can be protected.

Practical exercises using Microsoft Word

Exercise 10: Spellcheck

1. Type the sentence 'Eli is taking the test for his driver's liscence.'
   - **a** Perform a spellcheck on the sentence.
   - **b** Right-click and select Synonyms from the option box to find alternative words for 'test' and 'driver'.
   - **c** Use the Word Count feature to summarise the words and characters in the sentence.
   - **d** Use Track Changes to delete 'is' from the sentence and replace it with 'was'.
   - **e** Insert a comment at 'test' and type the note 'Did he pass the test?'

It is useful to move information from one part of a document to another and add information or other documents or programs into word-processed documents. If you are writing reports where some pictures, tables or charts need to be included, you do not have to leave spaces big enough to stick these images in later. You just insert the files from other programs (or copy and paste them) in the document at the location and adjust the size of the images. A limitation of some word processors is that they will not allow you to arrange the information in especially interesting ways. Remember that word-processing programs are not designed to perform complex layouts of combined information.

Combining files

Suppose you have three sections for an assignment in three separate documents. One way of combining a few documents is by using the copy or cut and paste features between documents. Note that you first need to have opened all necessary documents.

1 Select the document that has the text you wish to cut or copy from. Select and Cut or Copy the text.
2 Go to the document where you want to place your text.
3 Click the cursor at the desired location and Paste the cut or copied text.

Sometimes you may have two documents containing comments or edits that need to be combined into one final document. Another useful method is the *Combine Documents* feature. This creates a new document that highlights all edits as tracked changes. If you have several documents that need to be combined, start with combining two documents, then the new document can be combined with another document, and so on. With this feature you can select what should be viewed or hidden from view in the new document such as updated tables or formatting.

Importing data

File types

How do you make sure that the information created by one program will be understood by a different program? When you save your work, you will probably give it a name and then click OK. Look carefully at the box that then comes onto the screen and you will see a drop-down menu from which you can choose to save your file in a different format. Sometimes you may need to open or save a file as a type that is different from the one the program you are using will do by default (Fig 5.29).

The simplest common file type is TEXT (TXT is the file extension). All word-based programs will be able to open a TEXT file. There is a problem with TEXT files, however. They save only the words. They do not save the font, style and formatting information. Hence, the information does not look the same when you import it into a Word document, and you have to repeat all the appearance settings or formatting.

Rich Text Format (RTF) was designed to overcome this problem. It saves the font, style and formatting information, as well as the words. When you import an RTF file into another program, it should look the same as it did in the program that created it.

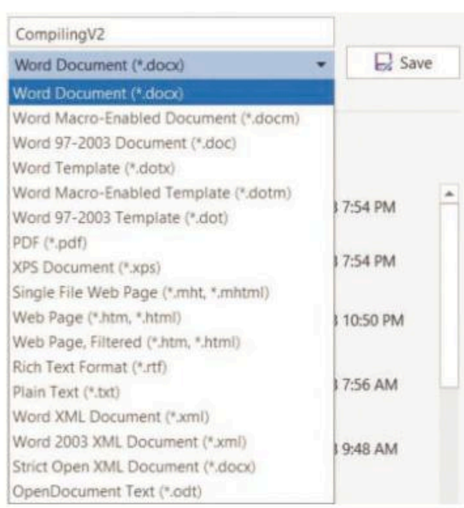


Fig 5.29 You can save a file in different formats

There are many other file types which are specific to particular programs and you may well be able to import these also – but you will need to check before you try any of them. If they are incompatible your text may appear garbled when viewed (Fig 5.30).

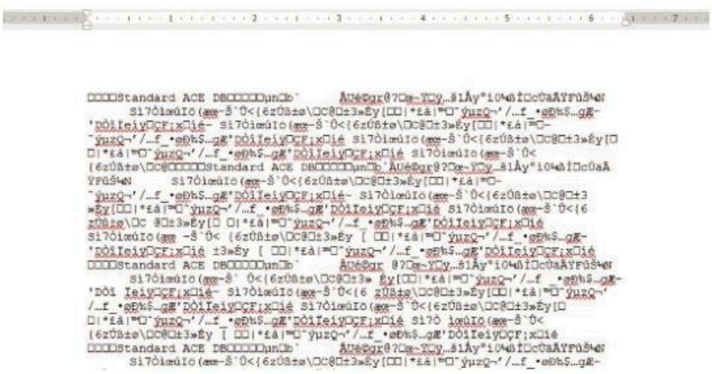


Fig 5.30 Incompatible file formats can lead to unreadable text

Switching between applications

To integrate data from different applications it is often necessary to have all relevant applications running and to switch between them. For example, you can switch between open Word and Excel files by selecting the application's button on the Task Bar at the bottom of the screen. As an alternative to using the Task Bar, some users prefer to use *Alt* + *Tab* to switch between applications. To do this:

1. Hold down the *Alt* key.
2. With the *Alt* key held down, press the *Tab* key until you see the name of the application you want.
3. Release the *Alt* key to switch to that application.

Excel is a spreadsheet program that makes number crunching, organising and presenting data very easy – even for the mathematically challenged.

To insert an Excel worksheet, for example, into a Word document, once the data already exists in an Excel spreadsheet, open the spreadsheet, select and copy the text, switch to Word and paste the copied text. Word converts the data to a table format.

Questions

1. Explain two ways of joining information in two documents into one final document.
2. Explain why a user would want to switch between different programs.

Long documents that contain many headings should have a table of contents. A table of contents is usually found near the beginning of a document. As shown in Figure 5.31, it is not actually a table, but a list of short headings that describe the different sections in the document. These headings are in order as they appear in the document with the page number to locate each section.

Table of Contents

Access 3
Alignment 4
The launch of the Centre 10
    Opportunities for students 17
University of first choice 18
    Registrations 22
    Assessment 25
    Dual certification 30
    Cohorts 35
Summary 42

Fig 5.31 A table of contents provides an overview of the document's contents and how it is organised

Selecting headings

Typing the headings and page numbers to create a table of contents can be time-consuming, especially if you need to add or modify a heading after it has been created. Fortunately, every word processor has this feature.

One of the easiest ways to create a table of contents is using a style. A style is a simple way to apply a specific font style, size and colour to selected text in one step. If the main headings in a document should be Arial, 14 point and black in colour, while another heading should be Arial, 12 point and black, then you can select each heading and choose the required style with one click. This is much faster when compared to selecting the font, then the size and colour for the heading. Figure 5.32 shows some of the styles that are available, with labels such as Heading 1, Heading 2, Title, and Subtitle that suggest where they can be applied.

Fig 5.32 Using styles simplifies the creation of a table of contents

Generating the contents list

Once the styles have been applied to the required headings, the table of contents can be generated. First, place the cursor near the beginning of the document or where the contents list should be placed. Then locate the Table of Contents icon (Fig. 5.33) and select a suitable table from the menu (Fig 5.34). The contents list is generated at that location. If different styles were selected, then you will see the various levels indented in the list.

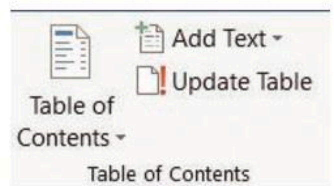


Fig 5.33 Group of icons for generating a table of contents

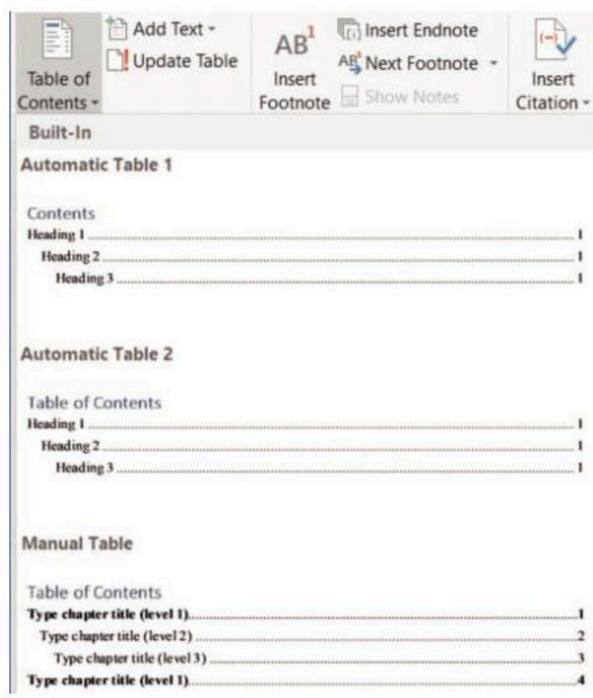


Fig 5.34 Options for generating a table of contents

Linking to a page

The contents list shows each heading and its page number. The contents list can be used to navigate to the actual page where the heading is located for that section in the document. For example, to go to the page with a heading entitled 'Cohorts', hold the *Ctrl* key while tapping the line for 'Cohorts' (Fig 5.35). The word processor locates the page and places the cursor at that heading in the document.

Fig 5.35 The ***Ctrl*** *+* ***Click*** *key combination navigates from the contents list to the select page*

Updating the contents list

If you wish to add another heading to the table of contents, select the heading and apply the appropriate style, then return to the contents list and select one of the Update Table options. A dialogue box prompts you to either update the page numbers only, or the entire list to include the new heading (Fig 5.36).

Fig 5.36 The page numbers or the entire list in the table of contents can be updated

Deleting one or more headings from the contents list is also achieved using the same Update Table option. The table is updated with the remaining headings and updated page numbers.

Questions

1. List the main steps required to generate a table of contents. Use the styles only for Heading 1 and Heading 2.
2. If a new section is added to a document, what are two methods that can update the table of contents?

Practical exercises using Microsoft Word

Exercise 11: Table of contents

1. Using the headings in Figure 5.31, make a document with each heading on a new page. Generate a table of contents placed at the start of the document.
2. Use *Ctrl* + *Click* to navigate to the Registrations heading. Then press *Enter* twice and add a heading called Fees.
3. Return to the table of contents list and update the table.
4. Use *Ctrl* + *Click* to navigate to the Cohorts heading. Delete this heading.
5. Return to the table of contents list and update the table.

Why Mail Merge?

Sometimes a business will want to send a standard letter to a lot of people but each letter has to be slightly different in some way. For example, if a business were to send out reminders for unpaid bills then the letters would be identical except for the customers' names and addresses and the amounts owing.

This could be done by typing the standard letter, saving it, and then making all the changes needed for each customer. The editing facilities would make this easy to do – delete the name and address and other details, and then type in the new information. But it would be a very tedious and repetitive job, especially if there are hundreds of letters to be edited.

Mail merge is an advanced feature in most word processors. Such programs automate this type of job and reduce the repetition. You must create two documents: one is a list of the details such as the names and addresses of the people you want to write to; the second is a master letter, with markers where the details are to be added. When these two documents are complete (and correct), you choose the merge function. This produces as many letters as there are people in the list by putting the appropriate information into the spaces marked in the master letter. This saves a lot of time. Along with letters, the creation of labels and printing envelopes are popular uses of mail merge.

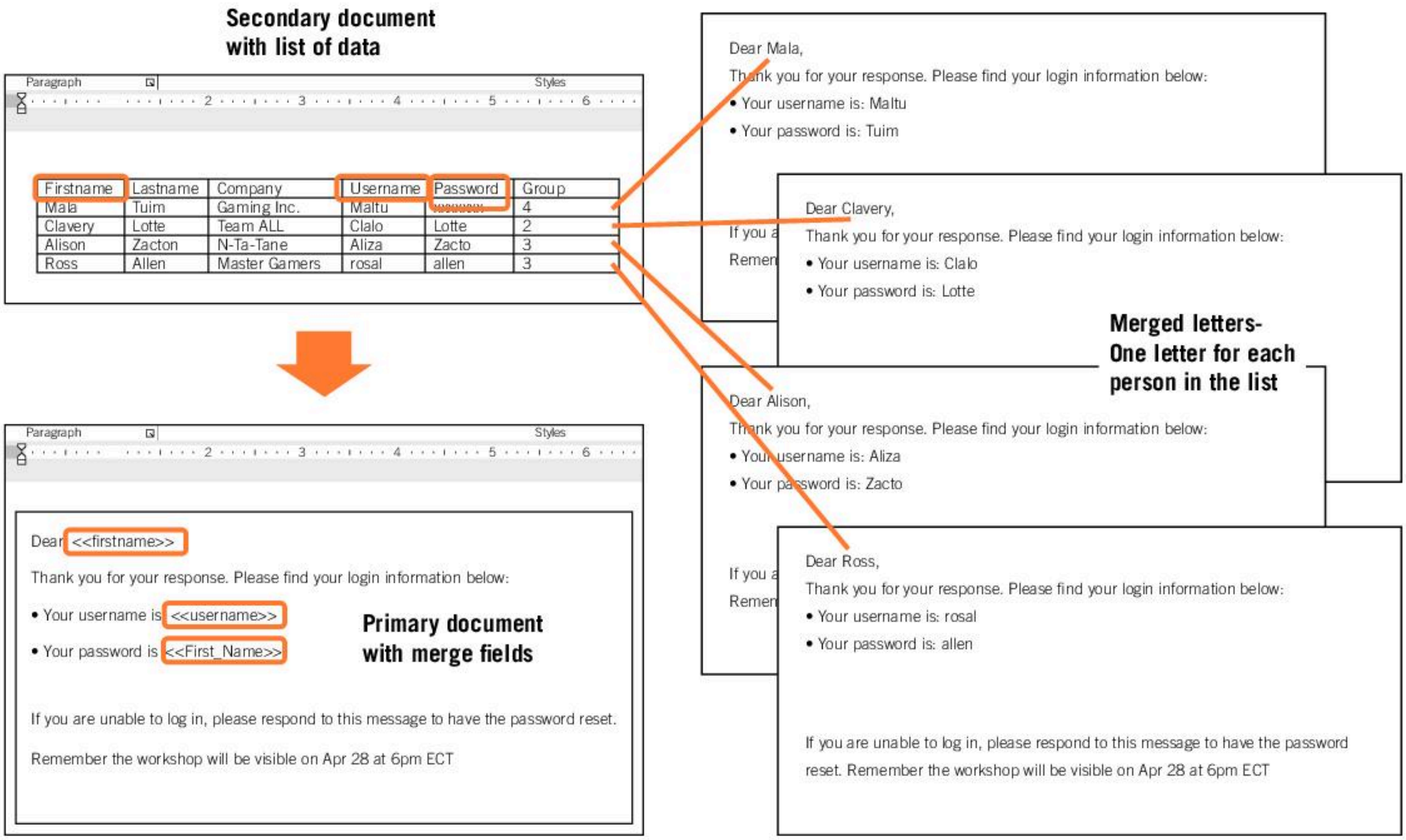


Fig 5.37 Mail merging lets you make many personalised letters from a list

There are four main steps that must be followed to create mail-merged letters.

1 *Create the list:* If the list containing the names and addresses of the people to send the letter to does not already exist then it must be created.
2 *Write the letter:* The letter to send should be created in the word processor. Special codes must be placed in the letter where the names and addresses of the customers should appear.
3 *Link the letter and list:* These two documents must now be linked together so that the Mail Merge function knows which file contains the names and addresses to put into the letters.
4 *Perform the mail merge:* When the mail merge is performed, one document is produced containing one letter for each person in the list. The names and addresses will be filled in on each letter.

Businesses, clubs, schools and other organisations use this method of personalising correspondence to circulate individualised information.

Selective mail merge

When letters are sent to only some of the people in a list, this is called a selective mail merge. Selective mail merges are much more useful than simple mail merges, which produce letters for everyone in a database.

For example, a club could select the names of people who need to renew their membership from a database of members. Mail-merged reminder letters could then be sent to these people.

Using Microsoft Word to perform a mail merge

Part 1: Creating a letter, label, or envelope

1 Navigate to the Mailings tab (Fig 5.38), then select the Mail Merge or Start Mail Merge icon.

Alternatively, select the wizard if you are new to using mail merge. A task pane will appear on the right of the Word document. Choose one of the types of documents: Letters, Envelopes or Labels.

Part 2: Setting up data records

The process of selecting recipients is identical for creating envelopes and labels. In the Mailings tab:

1 Click Select Recipients.
2 Select Type a New List.
3 In the New Address List window (Fig 5.39), type the data that is relevant to your letter under each field; for example, title, name and address information. You do not have to fill in every field. Click on the Customize button if you want to add, delete or rename any field.
4 To make another entry, click New Entry. Add all the data, one set at a time.
5 When you have finished entering all of your data, click OK.
6 In the Save Address List window, save the file for the data list by putting a name in the Filename field. This list is usually saved in the My Data Sources folder. You can save your list somewhere else but remember the location so that you can find it for the final mail merge.
7 Click Save.
8 Select Edit Recipients List. The contacts in the new list will appear in the Mail Merge Recipients window where you can edit the list if you need to. Note that you can also browse for a list that is already saved to use as your data, using Select Recipients by selecting Use an Existing List.

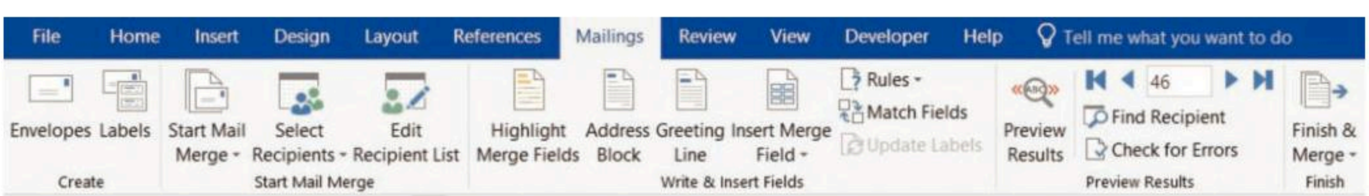


Fig 5.38 Mail Merge functions are on the Mailings tab

Fig 5.39 Adding details to the New Address List for the mail merge

Part 2A: Manipulating your data

In the Mail Merge Recipients window, you can select specific records by checking the boxes next to each recipient, or if there are a lot of recipients you can click the arrow next to the column heading to select a particular category in that column. If the arrow next to any column heading is blue, that heading has selected a particular category already. To check all names in your recipients list, click Select All. To uncheck all names, click Clear All. To **sort** the list, click the column heading of the item you want to sort by. When you have finished selecting your data for the merge, click OK to return to the Mail Merge Wizard.

Part 2B: Data sources you can use with Word

- ASCII text files
- Microsoft Word documents
- Microsoft Excel files
- Microsoft Access files
- Outlook contact lists.

Part 3: Completing the letter, label or envelope

You can now type your information on the page. Be sure to insert the merge fields where you want to merge names, addresses and other data using the recipient list. To insert a field:

1. Place the cursor at the appropriate position in the main document.
2. Click Insert Merge Field or, if using the Step by Step Mail Merge Wizard, select the More Items.
3. In the Fields window, click the field you want.
4. Click Insert, and then click Close.
5. Repeat steps 1 to 4 until all the fields are inserted into the main document.

Part 4: Completing the merge

1. Before previewing labels, click the option to replicate the layout of the labels.
2. Click Preview Results to view your letters, labels or envelopes.
3. Click Finish & Merge.
4. Click Edit Individual Documents.
5. In the Merge to New Document window, select the records you want to merge:
   - **a** To merge all the documents, click All.
   - **b** To merge only the document that you see in the document window, click Current Record.
   - **c** To merge a range of documents, click From, and then type the record numbers in the From and To boxes.
6. Click OK.
7. Microsoft Word will create a new merged document.
8. Print or save the document just as you would any other document.

Microsoft Word will open one new document that contains all the individual letters that were merged. Under most circumstances, you do not need to save the merged document. It is more useful to save the main document and merge it again if you need to. However, for your SBA you need to save the document just as you would any document for grading.

Questions

1 Identify two benefits of the Mail Merge feature.
2 State two documents that can be produced with the Mail Merge feature.
3 Why is selective mail merge useful?
4 Give one advantage of using different types of files as data sources.
5 State three choices of output for a merge document.
6 Explain three ways of selecting records to merge to a new document.

Practical exercises using Microsoft Word

Exercise 12: Performing a mail merge

1 Create the letter shown and save it as WORKSHOP.
2 Create the Word data source. The field names for the data source should be: Firstname, Lastname, Company, Username, Password and Group. Include the records below and name the data file INVITEES.
3 Merge to a new document.
4 Retrieve the WORKSHOP file and perform the merge again to all persons in the list in Group 2.

WORKSHOP

Dear «First_Name»,

Thank you for your response. Please find your login information below:

- Your username is: «username»
- Your password is: «password»

If you are unable to log in, please respond to this message to have the password reset.

Remember the workshop will be visible on Wed at 6pm ECT.

INVITEES

Firstname	Lastname	Company	Username	Password	Group
Mala	Tuim	Gaming Inc.	Maltu	Tuim	4
Clavery	Lotte	Team ALL	Clalo	Lotte	2
Alison	Zacton	N-Ta-Tane	Aliza	Zacto	3
Ross	Allen	Master Gamers	rosal	allen	3

Exercise 13: Creating a set of labels

1 Use the same data as in Exercise 12 to create a set of labels of your choice.

2 Place the field names on the label as shown below:

«First name» «Last name» Group «Group»

3 Name the document with the merge fields as Labels.

4 Before previewing the labels and completing the mail merge, click the option to replicate the layout of the labels.

5 Name the final merge as LabelsM.

Exercise 14: Creating a set of envelopes

1 Use the same data as in Exercise 12 to create a set of size 10 envelopes (4 1/8 × 9 1/2 inches).

2 Place the field names on the envelope as shown below

«First name» «Last name» C/o «Company»

Fig 5.40 When creating labels, you need to update the layout before merging

In order to print your document, select the File and Print commands (or *Ctrl* + *P*) found on many word processors. This sends the document to the default printer. There are various print options that you need to know, once you have finished your document.

Print Preview

The Preview option enables you to take a different look at your document. The document you see on the monitor will generally look the same as the printed result. This includes features such as footnotes, headers and footers, page numbers, multiple columns and page breaks. Note, however, that if your printer can only print in black and white, characters will be displayed in colour on the screen but printed in black and white.

The good news is that you do not have to print your document in order to review it. The Print Preview command displays all the features of the printed page. This allows you to scroll through the document using the scroll bar slide or arrows or the *PgUp* and *PgDn* keys.

You can also choose to quit Print Preview by tapping the *Esc* key on the keyboard to return to the document or print the document if there are no changes.

Print range

This option lets you indicate the pages of the document that are to be printed. You can choose to print the entire document page, one page or selected pages. Once you select the print option you want, the print command sends the job to the printer.

Copies

This option lets you indicate the number of copies to print, and whether multiple copies are to be collated (printed in order) or grouped (all page 1, then all page 2 and so on).

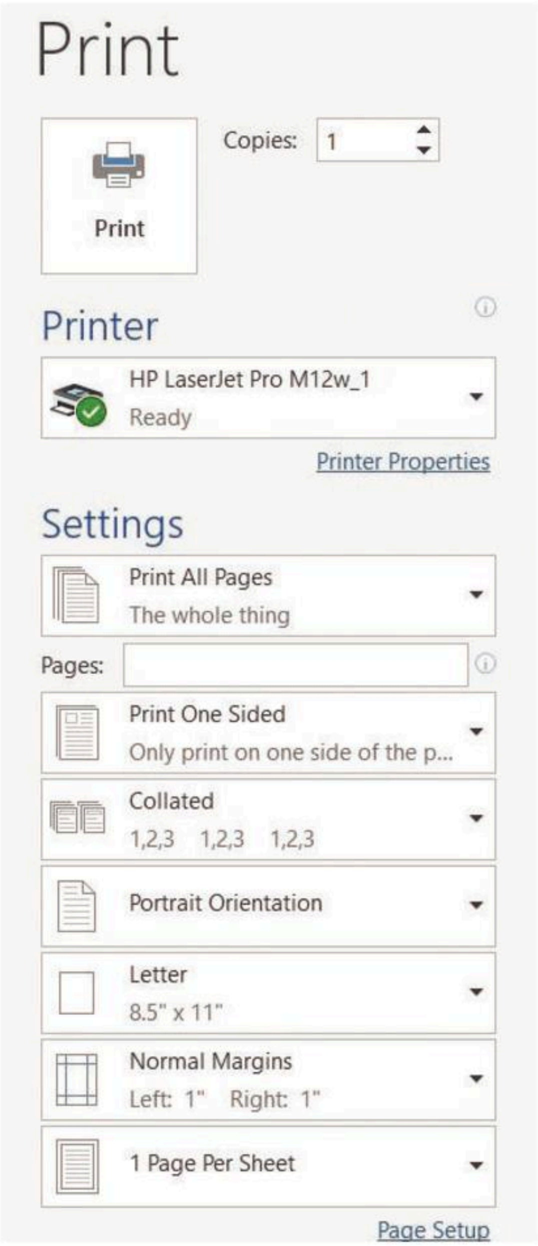


Fig 5.41 Options when printing a document

Questions

1. State two ways in which you can activate the print feature.
2. What is the difference between the Print and Print Preview commands?
3. Name the three ways of indicating which pages of a document are to be printed.
4. Explain two ways in which you can print several copies of a document.

5.9 Fillable electronic forms

A fillable electronic form is very useful for gathering information in soft copy. It can be emailed or completed online without having to re-enter the data. It can also be completed on a computer, laptop or mobile device. Fillable forms can be used for online quizzes, surveys, online registration, sign-up sheets, paying income tax online and online job applications, for example. They are better than paper-based forms because the fields can be formatted to accept only the required data. For example, fields can be formatted to accept text, dates, yes/no responses or an option from a list.

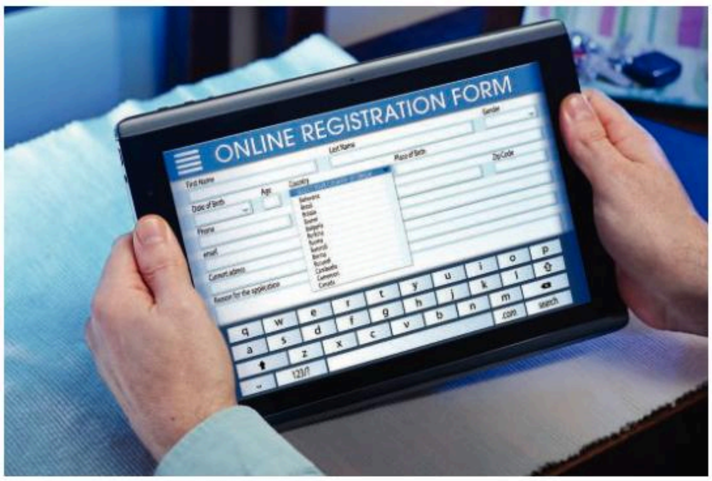


Fig 5.42 Online fillable forms can be completed using a mobile device

There are some applications that specialise in creating fillable electronic forms, however we will focus on designing forms using Microsoft Word and Google Forms.

The most common controls and their icons which are used to create fillable forms are described in Table 5.3.

***Table 5.3** Content controls for fillable forms*

Content control icon	Description
Aa Rich text	Users can type multiple paragraphs
Aa Plain text	Users type limited amount of text
Check box	Used for options: clicking in the box places an X in the box to select the option
Combo box	Select from list of choices or type in information
Drop-down list	Only select from list of choices
Date picker	Browse to insert a date or select today for current date
Design Mode	Used to customise the text on a form
Command button	Used in advanced forms to submit the form for processing. These buttons may be labelled as Submit or Click OK

Creating a fillable form

The following steps explain how to create an electronic form using Microsoft Word.

Add the Developer tab to display the content controls

Microsoft Word uses the Developer tab to display the content controls. However, as it is hidden by default, it must first be added to the list of visible tabs by customising the ribbon. The steps may differ slightly based on the version of Microsoft Word you are using. Once the Developer tab has been added, the list of content controls will be available to create your fillable form (Fig 5.43).

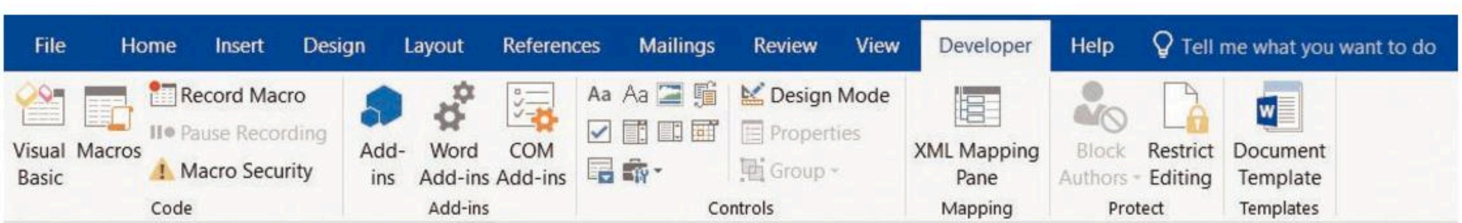
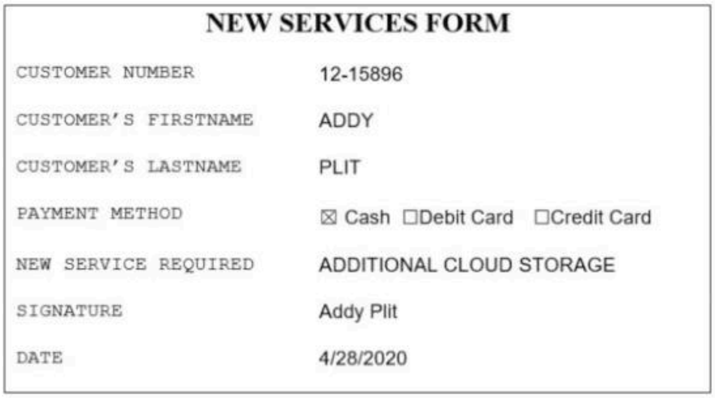


Fig 5.43 The Developer tab must be added before a fillable form can be created

Open a template or create a blank document to design the form

Microsoft Word has many online templates that can be used to help you design your form. Once you are online this feature allows you to search for templates in various categories for business, education or sports. However, you can also use a blank word-processing document to create your own form as shown in Figure 5.44.



NEW SERVICES FORM	
CUSTOMER NUMBER	12-15896
CUSTOMER'S FIRSTNAME	ADDY
CUSTOMER'S LASTNAME	PLIT
PAYMENT METHOD	☒ Cash ☐Debit Card ☐Credit Card
NEW SERVICE REQUIRED	ADDITIONAL CLOUD STORAGE
SIGNATURE	Addy Plit
DATE	4/28/2020

Fig 5.44 Sample online form with information added

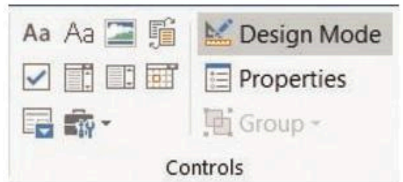
Add content to create the form

Depending on the content, you can create a table to type the text and controls in the various cells to organise the layout of the form by aligning the labels and content controls. A form can have multiple check boxes, text boxes, date pickers and drop-down lists, based on what information is required on the form. You should increase the font size for headings and use an appropriate font style, such as Times New Roman or Arial.

Content controls

For any form, you will need to know the different content controls. These allow you to enter specific types of data in the form. Content controls include check boxes, text boxes, date pickers and drop-down lists, and more advanced features such as command buttons.

Fig 5.45 Content controls are used to create fillable forms in Microsoft Word



Set or change properties for content controls

For each content control, the properties icon can be used to format how the data will be presented. For example, it is used to enter the options for a drop-down list, or how a date will be displayed.

Customise the labels of the form

Clicking the Design Mode icon allows you to customise the generic labels for the content controls. For example, if the generic label for the text content control is 'Click here to enter text', you can modify it to 'Click here to enter your last name'.

Protect the form

Once your form has been designed, you are ready to share it with others and gather some responses. Select the entire form and click the Restrict Editing icon in the Developer tab to prevent others from modifying the layout of the form.

Google Forms

Creating a Google Form is useful since it is created online and can be easily emailed or shared with others. Responses can also be viewed as soon as the user clicks the submit button and the data can be downloaded to a spreadsheet. These online forms can also be created using Google Drive or accessed by entering www.google.com/forms in a search engine.

You should name your form and then select the first content control for the first question.

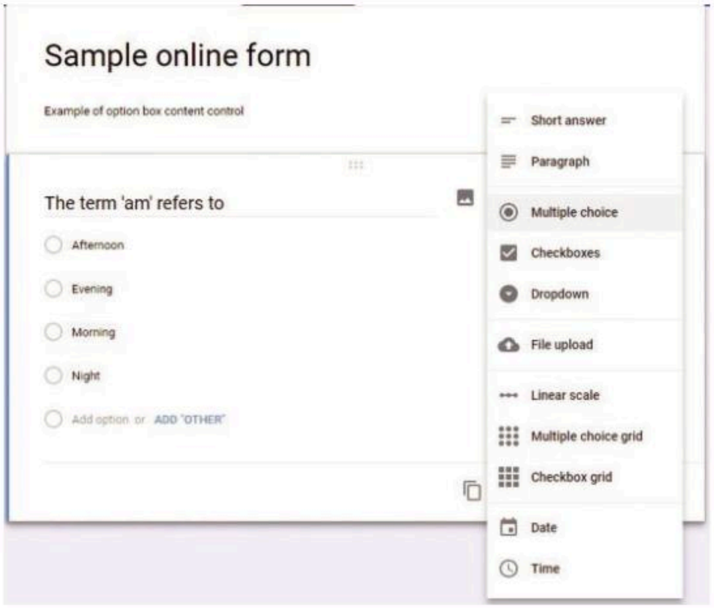


Fig 5.46 Example of a Google Form using a content control for a multiple-choice question

Note that the Google Form can also be shared via Google+, Facebook, and Twitter, and sent as an attachment to the user's email (Fig 5.47). As the form is submitted, individual responses or a summary of responses can be viewed (Fig 5.48).

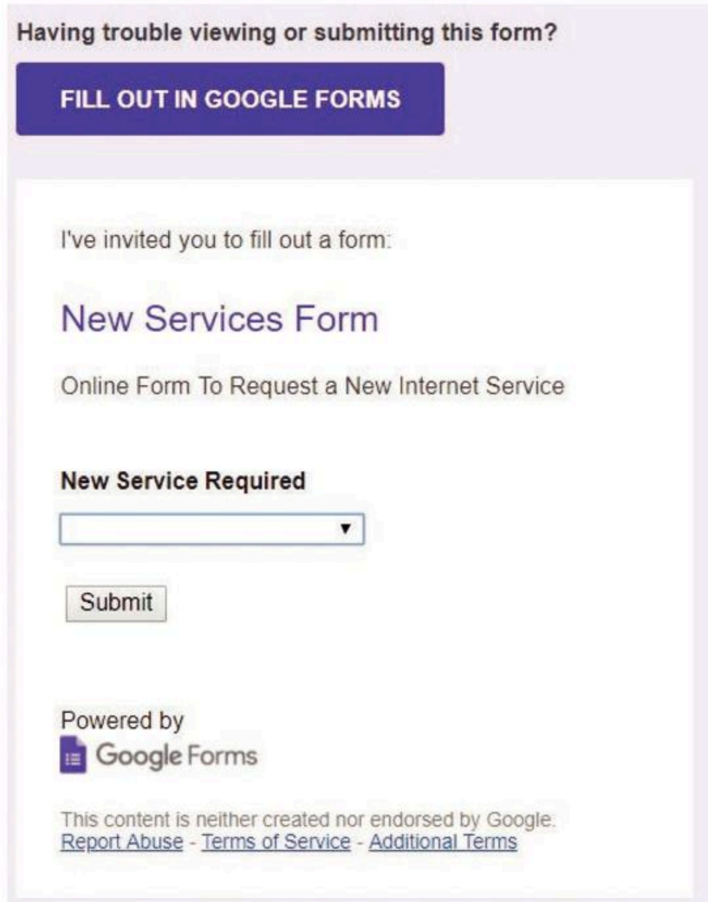


Fig 5.47 Google Form received as an email

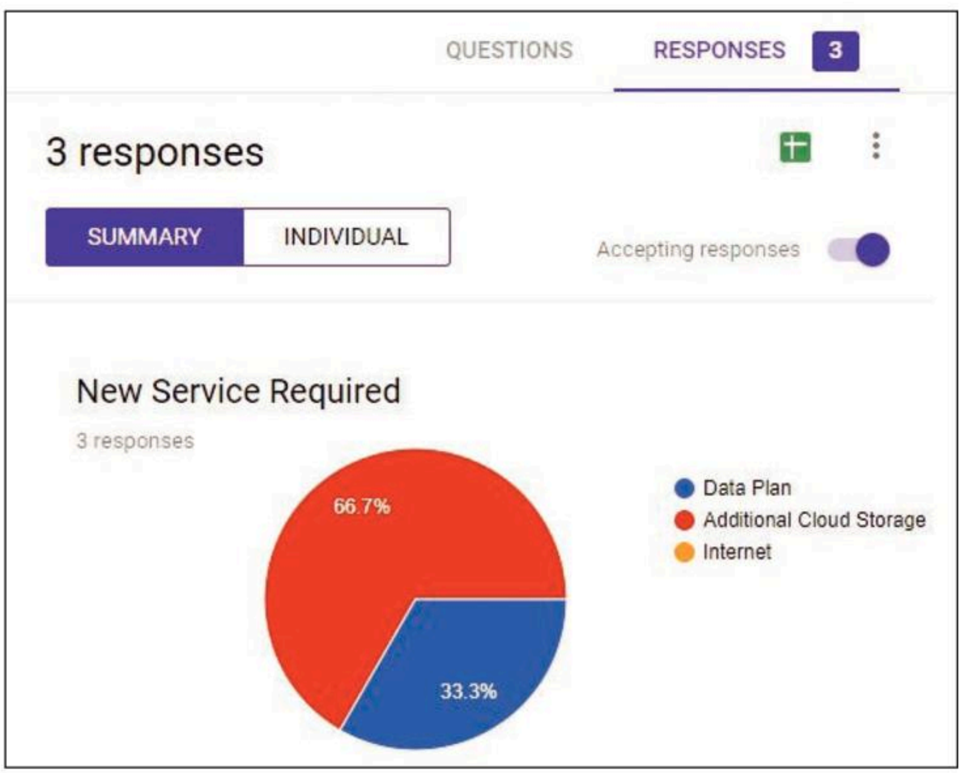


Fig 5.48 Responses received via Google Form

Questions

1 Explain one advantage and one disadvantage of paper-based forms and online forms.

2 Explain the difference between each of the following:
  a rich text and plain text content controls
  b combo box and drop-down lists.

3 Order the following steps for creating a fillable form:
  i Protect the form.
  ii Add content to create the form.
  iii Customise the labels of the form.
  iv Add the Developer tab to display the content controls.
  v Open a template or create a blank document to design the form.
  vi Set or change properties for content controls.

Practical exercises

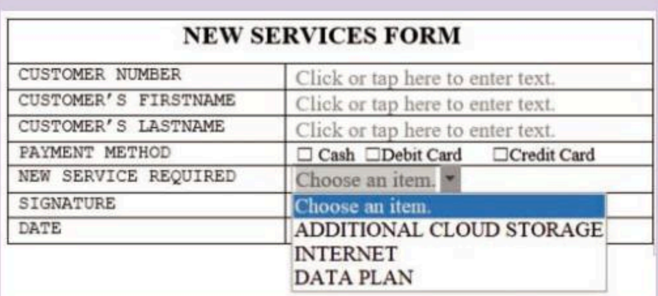
Exercise 15: Adding the Developer tab

These steps depend on your version of Microsoft Word. You can use a browser to search for 'Adding the Developer tab'.

1 Open a blank document.
2 Click File and then Options. Alternatively, click the Quick Access toolbar and select More Commands.
3 Click Customize Ribbon.
4 Look for the Main Tabs list and select the Developer check box. Click OK.

Exercise 16: Create a fillable form using Microsoft Word

1 Let's use a blank document to create a form based on Figure 5.44. The online form is for customers who are applying for a new Internet service.



NEW SERVICES FORM	
CUSTOMER NUMBER	Click or tap here to enter text.
CUSTOMER'S FIRSTNAME	Click or tap here to enter text.
CUSTOMER'S LASTNAME	Click or tap here to enter text.
PAYMENT METHOD	☐ Cash ☐Debit Card ☐Credit Card
NEW SERVICE REQUIRED	Choose an item.
SIGNATURE	Choose an item. ADDITIONAL CLOUD STORAGE INTERNET DATA PLAN
DATE	

Fig 5.49 Example used for creating a fillable form in Microsoft Word

2 Create a table with two columns and eight rows.
3 Type NEW SERVICES FORM in the first row. Then merge the two columns in the same first row.
4 Type the information in the left column and apply content controls in the right column as shown in the table below. Change the font style to Arial and the font size to 10 or 12 point.

NEW SERVICES FORM	
CUSTOMER NUMBER	Plain text content control
CUSTOMER'S FIRSTNAME	Plain text content control
CUSTOMER'S LASTNAME	Plain text content control
PAYMENT METHOD	Check box content control then type 'Cash' Check box content control then type 'Debit Card' Check box content control then type 'Credit Card'
NEW SERVICE REQUIRED	Drop-down list content control
SIGNATURE	Plain text content control
DATE	Date picker content control

5 A drop-down list is used for the service required question. Add the content control box for the drop-down list.
6 With the drop-down list still selected, click on the Properties option in the Developer tab.

A dialogue box will show so that you can add the options to the list (Fig 5.50).

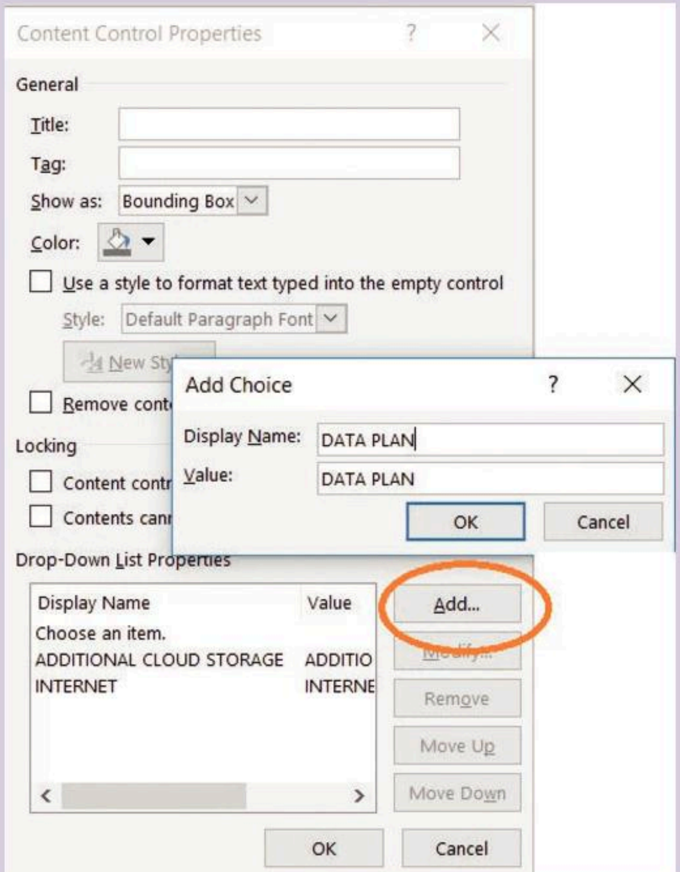


Fig 5.50 Adding options to the drop-down list

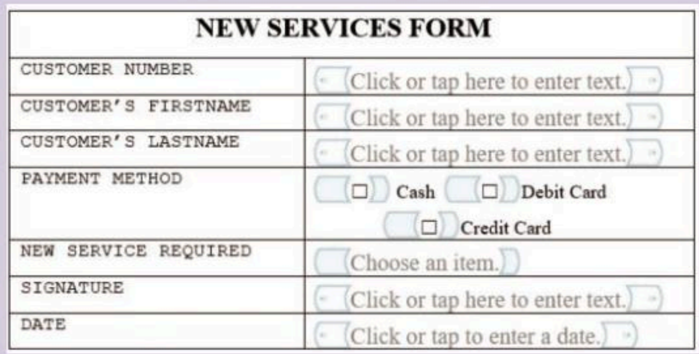
7 Click on Add in the dialogue box to add INTERNET. It will appear in the Display Name and Value areas. Click OK.

8 Click Add again, to add ADDITIONAL CLOUD STORAGE. Click OK.

9 Click Add again, to add DATA PLAN. Click OK.

10 Click OK to close the drop-list dialogue box.

11 In the Developer tab, select Design Mode to edit the different control options. Replace each of the content controls as shown in Figure 5.51.



NEW SERVICES FORM	
CUSTOMER NUMBER	Click or tap here to enter text.
CUSTOMER'S FIRSTNAME	Click or tap here to enter text.
CUSTOMER'S LASTNAME	Click or tap here to enter text.
PAYMENT METHOD	☐ Cash ☐ Debit Card ☐ Credit Card
NEW SERVICE REQUIRED	Choose an item.
SIGNATURE	Click or tap here to enter text.
DATE	Click or tap to enter a date.

Fig 5.51 Example in Design Mode to edit the text

12 Click on Design Mode so that you can edit and customise the labels of the content controls as shown in Figure 5.52. To preview the form, click on Design Mode again.

13 Select the entire form and click the Restrict Editing icon in the Developer tab to prevent others from modifying the layout of the form.

14 Test the form. Type 120163-03 as the customer number, your first and last name, data plan as the option from the drop-down list and select the current date.

Label	Design mode of content control	Replace with
CUSTOMER NUMBER	Click or tap here to enter text.	Click or tap to type Customer number
CUSTOMER'S FIRSTNAME	Click or tap here to enter text.	Click or tap to type first name
CUSTOMER'S LASTNAME	Click or tap here to enter text.	Click or tap to type last name
NEW SERVICE REQUIRED	Choose an item.	Choose type of service
SIGNATURE	Click or tap here to enter text.	Click or tap to type signature
DATE	Click or tap to enter a date.	Click or tap to select date

Fig 5.52 Editing the text in the form

Exercise 17: Create a Google Form

1 Ensure that you have a Google or Gmail account for this exercise.
2 Type www.google.com/forms in a browser.
3 Select a blank form.
4 Create the same form as shown in Figure 5.51. To add a new question, click the plus (+) to the right of the form.

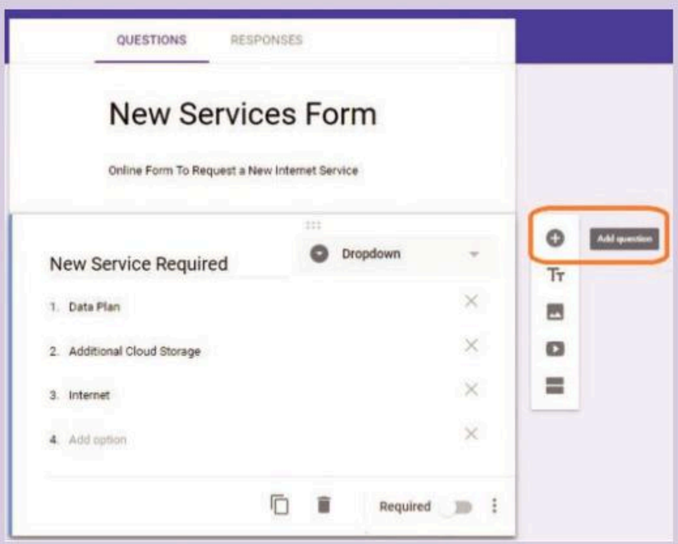


Fig 5.53 Exercise – Creating a Google Form

5 Click Settings in the top corner to preview the form.

6 Add your email address to test the form. Click the option to 'Include form in email'. Click Send to email the completed form (Fig 5.54).

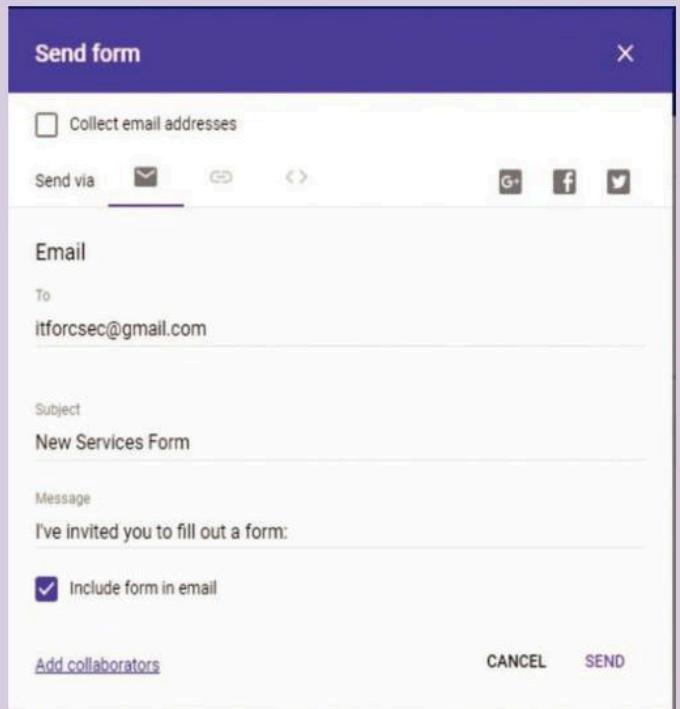


Fig 5.54 Exercise – Emailing the Google form

7 Check the email of the Google form. Complete the form and submit it.

Multiple choice questions

1 Each of the following are methods of editing text in a document, *except*:

- **a** importing and exporting
- **b** moving and copying
- **c** Find and Replace
- **d** spelling and grammar.

2 Text that is lowered to just below the line and printed at a smaller size is referred to as:

- **a** alignment
- **b** indent
- **c** subscript
- **d** superscript.

3 The feature that will look through the document to find one or more words that you specify and automatically change it with another word is called:

- **a** copy and paste
- **b** drag and drop
- **c** Find and Replace
- **d** spelling and grammar.

4 Text which appears at the top of each page but inside the top margin is called a(n):

- **a** endnote
- **b** footer
- **c** footnote
- **d** header.

5 The feature that highlights any editing that you make to a document is called:

- **a** comments
- **b** spellcheck
- **c** Track Changes
- **d** Word Count.

6 A document can be protected by each of the following features, *except*:

- **a** password
- **b** read-only
- **c** Mark as Final
- **d** Save A.

7 A list of short headings that describe the different sections in the document along with their page numbers is called a:

- **a** column
- **b** mail merge
- **c** primary document
- **d** table of contents.

8 Sending a document to only some of the people in a list is a feature in:

- **a** selective Mail Merge
- **b** Find and Replace
- **c** moving and copying
- **d** password protection.

Questions 9 and 10 refer to Figure 5.55.

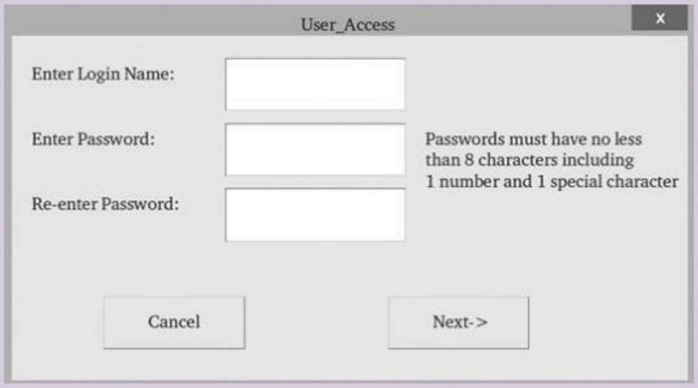


Fig 5.55

9 Two content controls used in the form are:

- **a** drop-down list and command button
- **b** command button and rich text
- **c** plain text and command button
- **d** rich text and drop-down list.

10 The content control where users type only a limited amount of data is called (a):

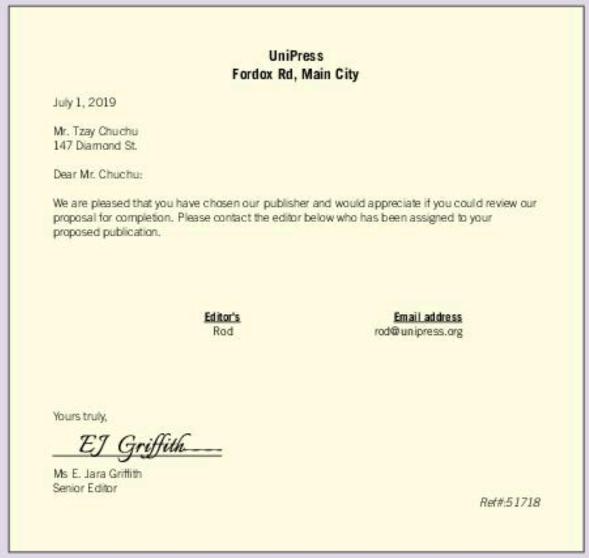
- **a** rich text
- **b** plain text
- **c** check box
- **d** drop-down list.

Short answer questions

11 Oliver finished a report on his computer and saved it as Report_OT.docx.

- **a** Name two input devices that would be useful for him when working on the report.
- **b** What does .docx in the name of the report represent, and what type application was used to create the report?
- **c** The next day he wanted to update it but keep a copy of the original report. Describe how he could create the updated report.
- **d** Explain how Oliver can add a graphic to the cover page of his report.
- **e** The report needs a table of contents.
  - **i** Explain why a table of contents would be useful for the report.
  - **ii** Explain where the table of contents should be placed in the report.
  - **iii** Write an example of a suitable table of contents containing the following titles:
    Introduction
    Updates to the project
    Additional staff
    Assignment of new staff
    Location of new staff
    Summary
- **f** Oliver now wants to send the updated report to 10 of his colleagues.
  - **i** Explain how Oliver can protect the report so that no one can make changes to it.
  - **ii** List two methods that he could use to send the report to his colleagues.
  - **iii** Describe one disadvantage of each method.

12 Catherine needs to send a copy of a letter (Fig 5.56), along with a proposal document, to 15 potential authors.


UniPress
Fordox Rd, Main City

July 1, 2019

Mr. Tzay Chuchu
147 Diamond St.

Dear Mr. Chuchu:

We are pleased that you have chosen our publisher and would appreciate if you could review our proposal for completion. Please contact the editor below who has been assigned to your proposed publication.

Editor's	Email address
Rod	rod@unipress.org

Yours truly,

EJ Griffith

Ms E. Jara Griffith
Senior Editor

Ref#:51718

Fig 5.56

- **a** Her assistant wishes to use the Mail Merge feature for this letter.
  - **i** State the two main documents required for Mail Merge.
  - **ii** Apart from the address in the letter, identify at least five fields which will change in the document shown above.
  - **iii** Name two other applications that can be used with Mail Merge.
- **b** The following data was saved in a file called 'Authors'.
  - **i** Name the feature that was used to create the format for the data.
  - **ii** If the list was sorted in ascending order by Author#, which author's first name would be at the bottom of the list?
- **c** Use your word-processing application to create the letter and list of data. Then use the Mail Merge feature to create envelopes of size 4 1/8" × 9 1/2" for authors only assigned to Rod.

Author#	Title	LName	FName	Address	Editor	Email	ResponseDate
131	Mr	Birnbaum	Steve	2042 Drive Rd	Raci	rachel@unipress.org	08/31/2019
230	Mrs	Bradhurry	Eleanor	9 Rogers Hill	Gena	geneva@unipress.org	08/15/2019
727	Mr	ChuChu	Tzay	147 Dia St	Rod	rod@unipress.org	08/15/2019
520	Mr	Fosten	Terence	P. O. Box 881	Gena	geneva@unipress.org	08/01/2019
750	Ms	Rhone	Jos	P. O. Box 98	Rod	rod@unipress.org	08/31/2016
622	Sis	Stens	Cecile	127 Pacif Lane	Raci	rachel@unipress.org	08/15/2016

CHAPTER 6

WEB PAGE DESIGN

6.1 Introduction to web page design

A web page is a document you can view using a browser. It may contain text, images, videos and hyperlinks to other web pages and files. Web pages are usually written in a language called HTML (HyperText Markup Language), a universal language that was developed to produce the layout of web pages. Do not become confused by thinking that HTML is a programming language – it isn't. It contains codes called 'tags' that a web browser uses to present the text and images on the web page. The browser then interprets these tags to produce and format the web page for you to view.

The use of HTML helps in two major ways:

- *To share documents*: HTML was created to help users share documents on the Internet, so that any browser can read a basic HTML document.
- *To link to other documents*: Hyperlinks use an Internet address for the related documents in the HTML code for the page. Clicking on the hyperlink either downloads the related material or views the document.

Any web browser can be used to access a web page. The most common browsers are Google Chrome, Microsoft Edge, Microsoft Internet Explorer, Mozilla Firefox, Opera and Apple Safari. Browsers let you view HTML files, but not create them.

You can open a web page by entering a unique web address called a URL in the address bar. For example, typing 'www.oup.com/oxfordcsecforit' opens the support web page for this text. You can also use a search engine to find a web page.

In the early days, web pages were intended to only provide information for education and the government. Now, new websites are being created and existing ones are being updated and modified every day.

A website can be a standalone web page or multiple web pages linked together through navigational links. Some general categories of websites are explained in Table 6.1.

Table 6.1 *Categories of websites*

Static website	The content of this websites remains generally the same and in this way is like an online version of a paper-based brochure. Viewers cannot search for content.
Editable brochure website	This website is the interactive version of the brochure website. Content is stored as it is updated so that visitors can search for and view past articles, web pages or other content.
Dynamic website	Here a user can login and create new content, add content, insert images and generally control what is viewed on the website.
E-commerce website	This is a website that is integrated to receive online payments from visitors to the website.
A web application	Web apps provide push notifications and can be added to a device's home screen without having to download it from an app store. Twitter Lite, Pinterest and weather apps are examples that push notifications to the user's phone or browser.

Websites are popular because they cater to all types of audiences for education, entertainment, sports or informational purposes. Knowing the purpose of a website therefore sets the tone for its content and organisation. Creating a website that is formal or informal reflects the seriousness or carefree impression that visitors will use to decide if they continue to browse the pages. Table 6.2 provides examples of some types of websites and their purpose.

Table 6.2 *Descriptions of websites and their use*

Use of website	Explanation	Examples
Entertainment	These websites use videos, graphics and live streaming to market their products, or for entertainment. Many online games and video sites use Adobe Flash software to display content, so sometimes people call entertainment sites 'flash' websites.	YouTube, Netflix, sports sites, online games
Corporate	Also called a business website, which uses the website for marketing and not to conduct business. The website provides information to users about the company and can also provide customer support.	cxc.org, oup.com
Shopping	These are e-commerce websites selling products. Users can browse and select products and pay online with methods such as a credit card or PayPal.	Amazon, eBay
Information	These websites provide users with a repository of historical and current information, such as news as it happens around the world. Other websites provide information in the form of encyclopaedias, training or general education.	Wikipedia, MSNBC, Fox News, CNN Notesmaster, Caribbean360
Community-building or social networking	These websites focus on the social interaction of people who want to communicate with others who share a common interest. Users share personal details, pictures and events with friends, family and acquaintances.	Facebook, Instagram, Flickr, SoundCloud, Twitter
Academic or professional	Users share their resumes, portfolios and career accomplishments online for potential employers and clients.	LinkedIn, Academia, ResearchGate
Personal or blogs	Personal websites are created and owned by individuals who share their personal profiles and specific interests. These websites are weblogs or blogs – generally online diaries, journals or editorials that reflect whatever is going on in the writer's life or business. The writer may even comment on politics or news or share personal opinions.	Personal blogs, forums, video blogs (vlogs)
Mobile	These websites are ideal for mobile devices and are often offered as an alternative to the normal version of a website when connecting with a mobile device. Their content is viewed better on a narrow screen width and uses less data to display the information.	Any website created for viewing on a mobile device
Directories	These websites are a type of online directory. However, instead of searching alphabetically, users can search terms and phrases in search engines.	Yellow Pages, Google, Bing

Planning your web pages

Your first task is to decide the purpose of your website. What do you want your website to do? This determines what content you are going to put on your web pages, how it will be organised, and how the pages are linked.

Content

It is very important that the message of your website is presented in a manner that captures the attention of those who visit it. The initial screens should attract visitors' interest so that they want to browse the site. The main screens and connecting web pages should supply enough information and maintain a visitor's interest enough to encourage repeat visits. The use of one or more combinations of colour, images, sound, video and tone of language can capture or lose a visitor's attention.

Organisation

Web pages should be well organised, with information arranged in categories and subcategories. This helps the user to browse through information in a sequential and logical manner, so that interesting sub-topics can be selected for further reading. You should therefore sketch how the various web pages relate to each other and how you would want your website visitors to view the content on each web page.

Navigation

Navigational links can include pull-down and pop-up menus or hyperlinks to other pages or documents. Any visitor to a website should be able to move through the main categories or pages in a logical manner or go directly to an area of interest. **Hyperlinks** are used to connect web pages to other web pages or locations within the same web page or external documents. Other navigational links are 'breadcrumbs' which are seen in a single line below the web page header. **Breadcrumbs** show the path a visitor would have taken to access the current page, with each one being a sub-category of the one before it. An example of a breadcrumb or breadcrumb trail is:

Home > Plants > Potted > Flowers

The visitor can go directly to any of the pages in the breadcrumb by clicking on the hyperlinks in it, including 'Home', which will take them back to the opening screen or main web page. Another useful set of links websites can provide are those to other websites that are related to your website's content.

Figure 6.1 shows the address or URL of a particular web page, also called the **path**.

ⓘ www.oup.com/oxed/international/itforcsec/

Fig 6.1 The URL of a web page is shown in the address bar

Economy

You should be aware of the number of web pages a visitor must view before seeing the page of interest. Also, not all users have the same Internet connection, so modem speeds for dial-up customers may increase the time taken to view a page that has many images or videos. Websites aimed at, or optimised for, mobile devices also take this loading-time issue into consideration.

Security

A website should have ample security features to assure confidence if users are providing sensitive data, such as credit card or personal information. These security features should include measures to prevent hackers and viruses from compromising the integrity of data, information and hardware.

Questions

1 Name the application that is used to view a web page.

2 State the name of the universal language that is used to produce web pages.

3 State the names of three common browsers.

4 Suggest two ways in which a user can open or locate a web page.

5 Explain the association between a website and web page.

6 State the category of website where users must login to edit content.

7 State the general purpose or category of website that is used for:
   - **a** online purchases
   - **b** viewing on a small device
   - **c** socially interacting with others.

8 State three features that should be considered when planning a website.

As you start your design, you need to think about who will be interested in the web pages and consider the layout and links to other pages. Remember that every web page is different, but most have certain features that are common to all web pages. There are many online website builders that offer free design features or templates so that users spend less time with formatting and more time focusing on the content. A general layout of a web page is shown in Figure 6.2.

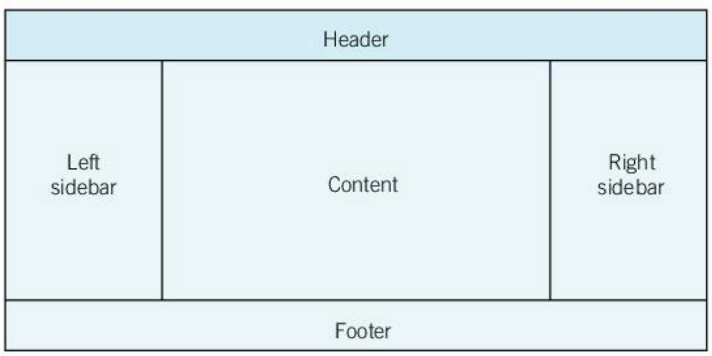


Fig 6.2 General layout of a web page

The **header** displays the name of the website, web page, blog name, logo or company name. The name is usually placed at the top left corner of each web page. The header also provides a short statement or phrase that explains the purpose of the web page. If you are on a web page that is not the main page, clicking on the header takes the user back to the main page.

The left or right **sidebar** includes a navigational bar or menu that shows links to each of the major sections of the web page.

The content area contains the most important paragraphs or images on the web page. The information that you place here should attract the visitor into reading more and staying on the web page or website.

The **footer** should include any other information that is important and should be included on all web pages. It should include how recently the content was placed there, any contact information and copyright, legal or privacy notices.

Web page content

You should really create a web page based on a topic that you know something about. If this is the first web page you have created, do not make it too large and ambitious. Some ideas for web pages could include advertising a trade or business such as hairdressing, landscaping or music production.

A simple structure will be sufficient to develop your skills at preparing the information for display and building the site. Sketch a plan of the website's structure to get an idea of what you want to share (Fig 6.3). You can also visit each of the recommended website builders in the syllabus. Each one provides samples of online stores, blogs, business and personal websites.

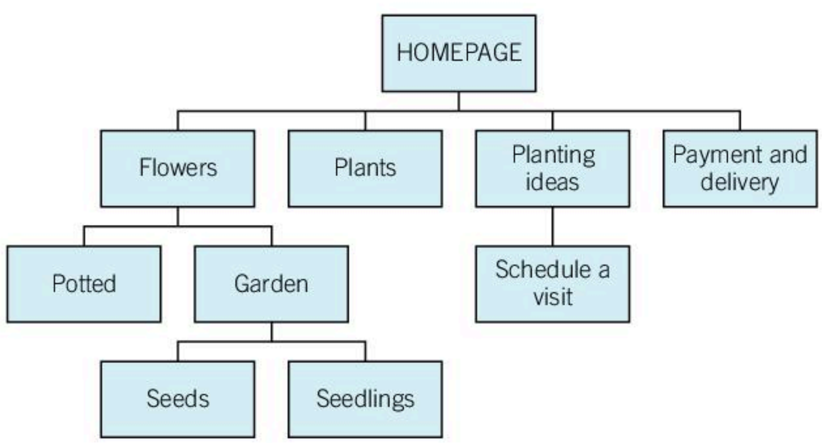


Fig 6.3 Plan the structure for your web pages

Backgrounds and themes

When you create a web page, you should consider using a background or theme to help capture the attention of a visitor. This includes the use of colour, images or watermarks to create an interesting background for your web pages. A theme can be used to give your web pages a professional look, for example having all navigational links looking similar, and the background colour, the font and font colour consistent throughout.

Text and images

Many website builders have options for you to insert, upload, edit or remove your text, images and videos. Images and videos can be embedded among the text, or the text can flow around the image (Fig 6.4). If you create simple web pages using Microsoft Word, any text, graphics, tables, hyperlinks and other information in the document will be converted to a web-compatible format when you save the document as a web page. Although early versions of Microsoft Word could not create web pages, saving your document as a single web page converts any text and formatting into HTML code. Any images are also converted into web-compatible graphic formats.

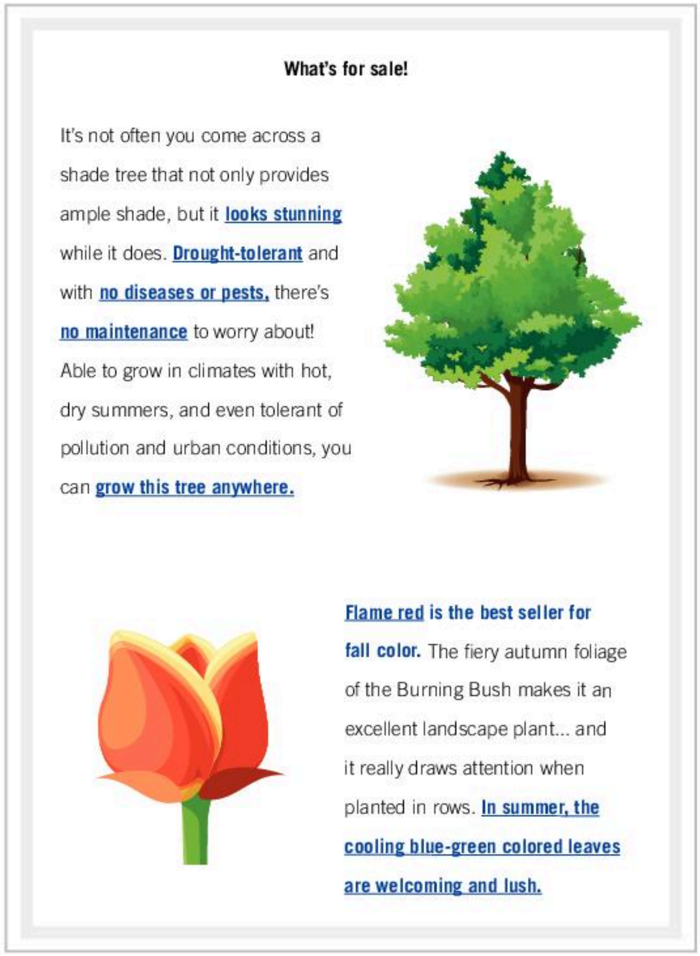


Fig 6.4 Images are useful to support the content on the web page. The hyperlinks on this page are shown in bold.

Hyperlinks and bookmarks

Hyperlinks and bookmarks can add structure, organisation and navigational functionality to your web page. Visitors to a website use hyperlinks to move from web page to web page. A hyperlink can be an icon, image or word that automatically opens another file or document for viewing. You click on a hyperlink to:

- be directed to another web page, file or document
- be directed to another position within the web page (also known as using a bookmark)
- open a new email message to send using contact details given on the website.

You should therefore have a table of contents navigational area or home area to allow visitors to use hyperlinks to select specific areas of interest. Hyperlinks can be created in Word, and function the same as they would on an actual web page. You can create the hyperlink so that when the user clicks that particular portion of text or even an image, the user is directed to your specified place in the current document, to a web page or to a given email contact address (Fig 6.5). You can also fill out a **ScreenTip** describing the link to those who may want a description.

Fig 6.5 The underlined text in blue indicates a hyperlink

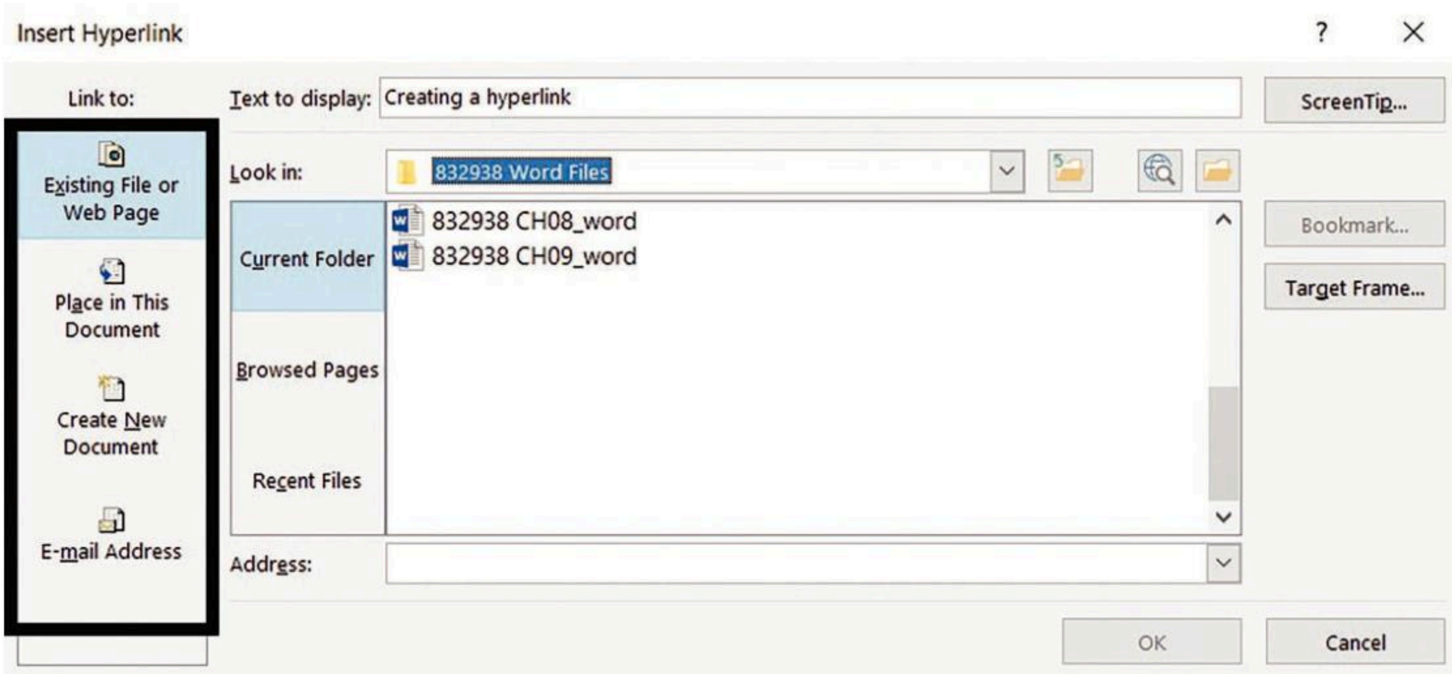


Fig 6.6 A hyperlink can be created to link to different documents and locations

Bookmarks are hyperlinks that jump to a different part of the web page. They are especially useful on very large documents with many words or sections. They are typically a name, word or phrase that you assign to a location on the page that you may want to reference later. This means that rather than looking through the whole document or page searching for the location, the bookmark feature can easily locate it.

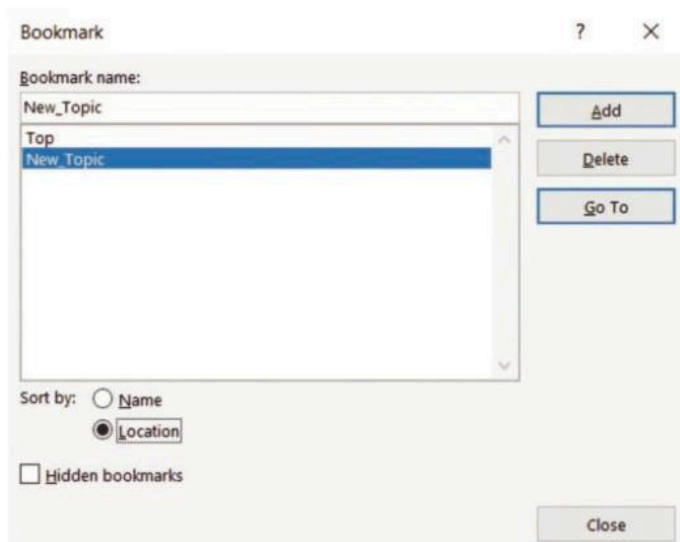


Fig 6.7 Bookmarks are hyperlinks that jump to a different part of the web page

Note that when naming a bookmark, it should:

- begin with a letter and can include numbers
- not have any spaces between the words. However, you can use the underscore to join words for longer names.

Questions

1 In the general layout of a web page, explain what is displayed in the header.

2 Use Figure 6.3 for the following questions:
  - **a** Write the breadcrumbs that show you have navigated to Seedlings.
  - **b** Figure 6.3 is not the only way that the website can be organised. Create another sketch on how **you** would rearrange the web pages for a different perspective.

3 Explain how a bookmark is similar to a hyperlink.

4 Describe three ways in which a user can be directed by clicking on a hyperlink.

Practical exercises using Microsoft Word

Exercise 1: Adding a bookmark

1 Open a blank Word document.
2 Type =rand(6,4) and press *Enter*. This creates random text in your document. Save the document as 'Chapter6Ex'.
3 Select the first word on the page.
4 Select Insert on the Menu bar or ribbon, then choose Bookmark.
5 Type the name 'Top' and click Add.
6 Locate the sixth paragraph and select the last word in the paragraph.
7 Select Insert on the Menu bar or ribbon, then choose Bookmark.
8 Type the name 'End' and click Add.

To go to a bookmark:

1 Select Insert on the Menu bar or ribbon, then choose Bookmark.
2 Select the bookmark name and click Go to.
3 Try locating the Top and End bookmarks.

To delete a bookmark:

1 Select Insert on the Menu bar or ribbon, then choose Bookmark.
2 Select the bookmark name and click Delete.
3 Delete the bookmark named End.

Exercise 2: Using hyperlinks to be directed to an existing document

1 Open a blank Word document.
2 Type the following sentence: 'This sentence contains a hyperlink HERE.'
3 Select the word 'HERE'.
4 Click Insert on the Menu bar and select Hyperlink. In recent versions of Microsoft Word, you select Link from the Insert tab. Another option is to right-click on the text and click Hyperlink (or Link).
5 On the left pane, select Existing File or Web Page.
6 Browse to locate and select the 'Chapter6Ex' document.
7 Click OK.
8 Move the pointer over the word 'HERE'. Press *Ctrl* + Click to open the 'Chapter6Ex' document.

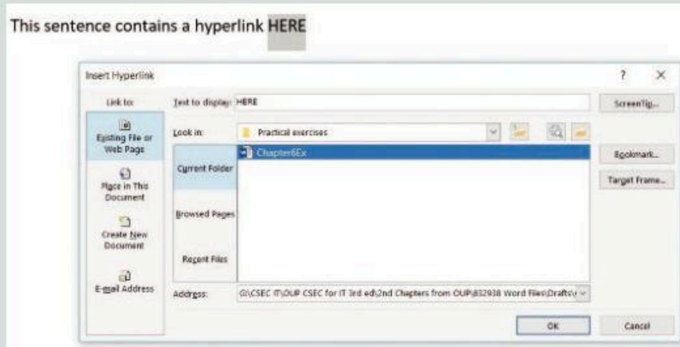


Fig 6.8 Linking to an existing document

Exercise 3: Using hyperlinks to be directed to a website

This exercise will show you how to create a hyperlink to access a website in your browser. To see this happen, you should have access to the Internet and be online.

Most versions of Word recognise the format of web addresses and other file paths, so when you type one in and press *Spacebar* or *Enter* it automatically creates a hyperlink in that text. For example, type 'www.oup.com/caribbean' in a Word document. As you press *Enter* or the *Spacebar*, the website becomes a link that looks like www.oup.com/caribbean

To create a hyperlink using specific text:

1 Open a blank Word document and type the following sentence: 'This Sentence contains a link to a website.'
2 Select the word 'website'.
3 Select Insert on the Menu bar or ribbon, then click Hyperlink (or Link). Alternatively, right-click on the text and click Hyperlink (or Link).

4 On the left pane, select Existing File or Web Page.
5 In the Address area in the lower part of the dialogue box, type 'www.oup.com'.
6 Click OK.
7 Hover the pointer over the word 'website'. Press *Ctrl* + Click to open the link in your browser.

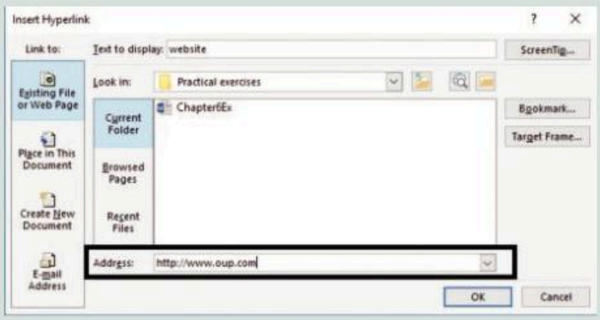


Fig 6.9 Linking to a website

To create a hyperlink using an image:

1 Open a blank Word document and add an image by copying and pasting one into the document or using the Insert tab and selecting one of the options in Illustrations.
2 Select the image.
3 Select Insert on the Menu bar or ribbon and click Hyperlink (or Link). Alternatively, right-click on the image and click Hyperlink (or Link).
4 On the left pane, select Existing File or Web Page.
5 In the address area in the lower pane, type 'www.oup.com'.
6 Click OK.
7 Hover the pointer over the image. Press *Ctrl* + Click to open the link in a browser.

Exercise 4: Using hyperlinks to be directed to a bookmark

This exercise uses the Chapter6Ex document to move the cursor to a place within the same document. It is similar to using a bookmark.

1 Open the Chapter6Ex document or use a document with at least six paragraphs of text.
2 Locate the fifth paragraph and select the first word in the paragraph.
3 Select Insert on the Menu bar or ribbon, then click Hyperlink (or Link). Alternatively, you can right-click on the text and click Hyperlink (or Link).
4 On the left pane, select 'Place in This Document'.
5 Select the bookmark named Top.
6 Press OK.
7 The selected text in the paragraph now looks like a hyperlink.
8 Use the *Ctrl* + Click option on the hyperlinked word. You will notice that the cursor has moved to the location at the top of the document.

Exercise 5: Using hyperlinks to be directed to a new document

This exercise uses the Chapter6Ex document.

1 Locate the second paragraph and then select the first word in the paragraph.
2 Select Insert on the Menu bar or ribbon, then click Hyperlink (or Link). Alternatively, right-click on the text and click Hyperlink (or Link).
3 On the left pane, select Create New Document.
4 For the new file, type the name 'Exercise 5 – hyperlink to new document'.
5 You can use the current location shown under Full path or click Change and browse to another location such as the desktop or your secondary storage device.
6 Select the option to Edit the new document later.
7 Click OK.
8 Hover the pointer over the text you created the link in and press *Ctrl* + Click to be directed to the new document named Exercise 5 – hyperlink to a new document.

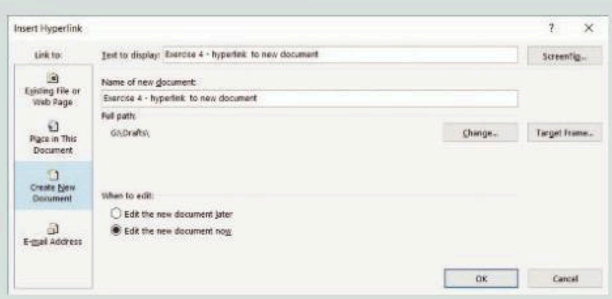


Fig 6.10 Creating a hyperlink to a new document

Exercise 6: Using hyperlinks to create a blank email message

A quick way to create a hyperlink to a blank email message is by typing the email address in a word document and pressing *Enter* or the *Spacebar*. However, if the email address link is to be included in some text you may want to use this second option.

1 In a blank Word document, type 'Email Customer Support', then select the text.
2 Select Insert on the Menu bar or ribbon, then click Hyperlink (or Link). Alternatively, right-click on the text and click Hyperlink (or Link).
3 On the left pane, select 'Email address'.
4 Type your email address or alternatively use itforcsec@gmail.com (notice 'mailto:' appears in front of it automatically).
5 Type 'Exercise 6' as the subject of the message.
6 Click OK.
7 Hover the pointer over the text and press *Ctrl* + Click to open a new email message with the recipient and subject you have specified.

Exercise 7: Editing, copying and removing a hyperlink

To manage your hyperlinks, first right-click on the text or image, and then click the option to Edit, Copy or Remove the hyperlink. The pop-up menu is shown in Figure 6.11.

1 In a blank Word document, type 'More with less'.
2 Select the word 'More' and create a bookmark named First. You can look at the steps in Exercise 1 to remind you how to do this.
3 Select the word 'less' and create a hyperlink that will jump to the bookmark named First. You can look at the steps in Exercise 4 to remind you how to do this. Look for 'First' in the tree of bookmarks that appears when you have selected Place in This Document on the left pane.
4 Copy the word 'More', move the cursor to the right end of the lines and press *Enter* to move to a new line. Paste the text on the new line. Then create a hyperlink on your pasted text to open the 'Chapter6Ex' document. You can look at the steps in Exercise 2 to help you do this.
5 Edit the new hyperlink from step 4 and change the Text to display at the top of the dialogue box to 'Even More'.
6 Edit the Even More hyperlink on the second line so that it opens a new document named Chapter6NewEx. You can look at the steps in Exercise 5 to help you with this.
7 Remove the hyperlink named Even More. Use the right-click menu item shown in Figure 6.11.

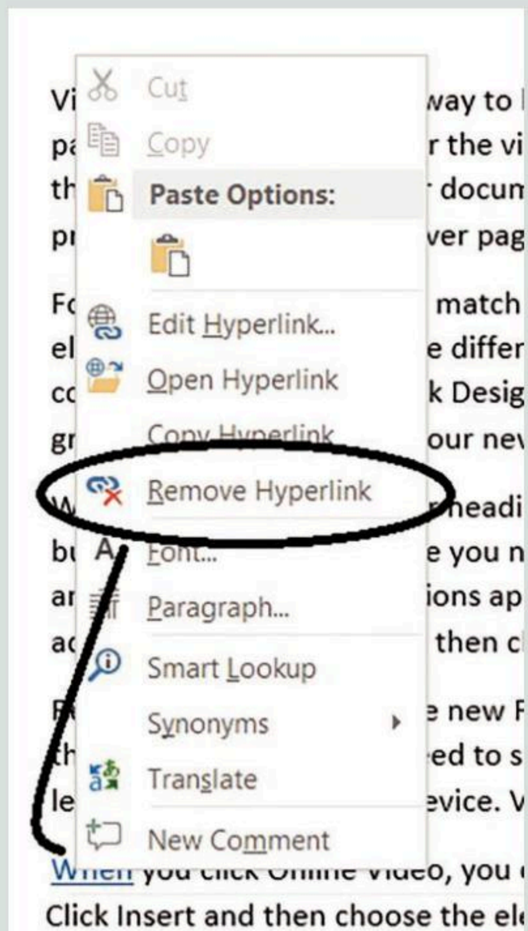


Fig 6.10 Removing a hyperlink

There are many online web builders available to assist users with creating their websites and web pages. While a word processor can create a basic set of web pages and connect them via hyperlinks, the syllabus also recommends a few web builders such as webnode.com, weebly.com and wix.com

Getting started

Most web builders require registration of the user's email address and password along with an initial name for the website before you can start to create any web pages. Once you have registered, you need to select the type of website that you wish to create. For example, will your website be one for personal use or business?

Once you have made your selection, the web builder could filter some website templates for you to preview and select one that will be used to create your content.

Adding content

Now that you have chosen your overall template, you can use the options available to browse and add other web page designs that are suitable for your website concept (Fig 6.12). Some designs may contain columns, graphics or contact information, while other may contain sections for graphics or videos. The sample designs contain random text and pictures for you to preview your web page. However, the web builder also includes options to change font types, font sizes and text alignment; add your own graphics, pictures or video; and edit the background colour or upload a background image. Added features, such as the integration of Google Maps to navigate to the location of your business, a contact form or subscription page are available for visitors to receive updated information.

If you are not sure of the order or layout of your web pages, most web builders allow you to rearrange them using drag-and-drop options. Lastly, there are options to add a logo, special slogan or social media icons to personalise your web pages.

Finalising your web pages

Before publishing your web pages on the Internet, you should preview the checklist to test your website:

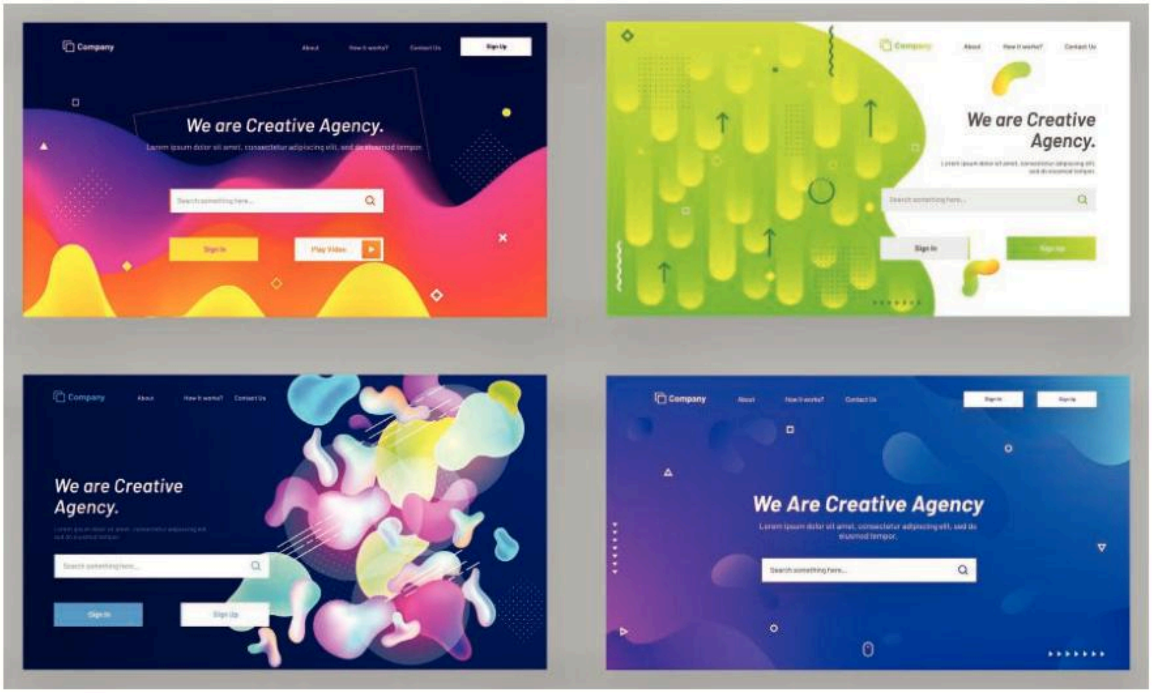


Fig 6.12 Templates help you decide on a suitable design for your web page

- Make sure that all the headings, links, images, font colours and so on complement the purpose of your website and are not too dark or too small when previewed.
- Click on each hyperlink to make sure that it directs you to the correct web page.
- Check that any animations, videos or sounds play as they should.
- Check that email addresses are valid and working.
- Check for orphan pages. These are pages that contain no links back to the previous web page or to the homepage. Sometimes the only way to go to the previous page is to use the Back button, but this does not always work.
- Check that the page titles on each web page are sensible and not too wordy. Page titles are important, since they appear in search engine results and in browser bookmarks.
- Since you do not know how your visitors will access your website, you should also preview it using a mobile device to see how it looks. Can you view the content easily? Is the design suitable for this small viewing window?

Once you are satisfied that all links and web pages are functioning, you are ready to publish your website.

Most web builders use a single click to publish your website. However, you can continue to update content and features as necessary.

Questions

1 What do most web-building applications require before you can create a website?

2 List some of the features that are available for creating a website.

3 Explain why you should test your website before publishing it.

4 Describe three checks to test a website.

5 What is the name of the web page that contains no links back to the previous web page or to the homepage?

Practical exercises using a notes program

Exercise 8: Creating a static web page

1 Locate and open Notepad, or alternatively WordPad. Note that writing HTML code is not required in the syllabus but this exercise demonstrates how it works.

2 Type the following as accurately as possible.

```
<html>
<head>
<title> A title goes here </title>
</head>
<body bgcolor="white" text="blue">
<h1> A web page </h1>
This is a line of text that will be viewed as a web page.
</body>
</html>
```

3 Save the file as MyPage.html. You can save it on the desktop but make sure to note EXACTLY where you saved the file. Then minimise this window.

4 Browse to locate the MyPage.html file. Then double-click the file.

5 You should see your text in the browser.

6 Now, maximise the MyPage.html window, and change the blue in 'text="blue"' to green. Save the file again.

7 Now maximise the browser and refresh the page. The colour of the text should change in your browser.

8 Try changing the colour to orange, red and violet, saving the html file each time, and refreshing the browser after each change.

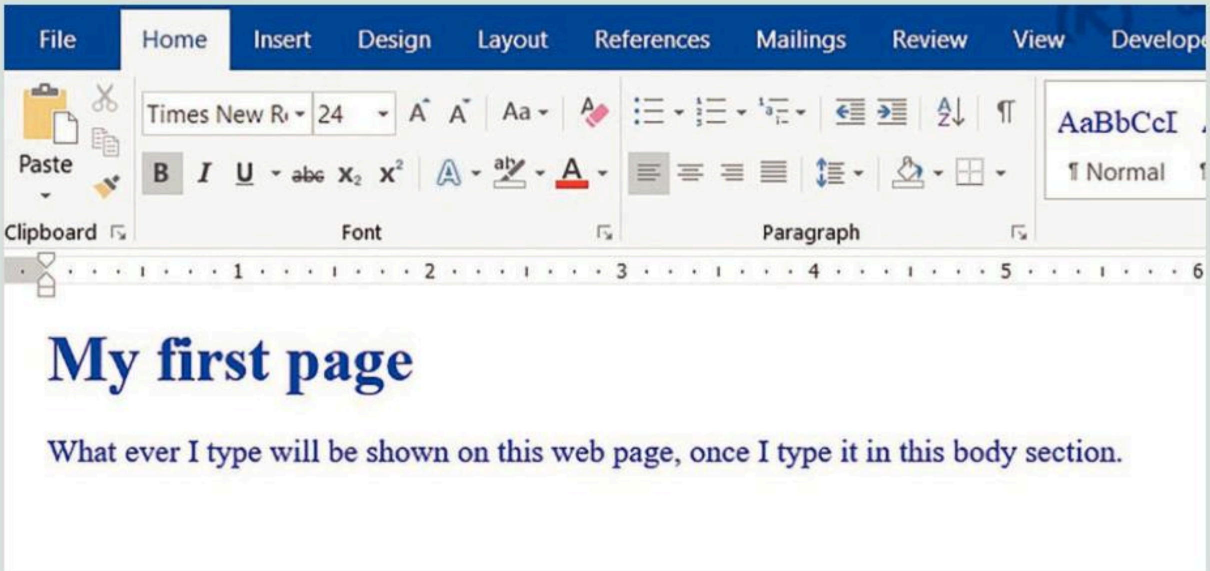


Fig 6.12 Creating a static web page

Practical exercises using an online web builder

Exercise 9: Use a free web builder to create web pages

1. Select one of the recommended free website builders in the syllabus and complete the free online registration.
2. Look at the basic website structure in Figure 6.3. Create a web page using one of the rectangles in the structure to develop an idea for your web page.
3. Include pictures and text to enhance the look of your web page.
4. Ensure that the fonts and colours are suitable for the topic.

Exercise 10: Using a web builder to create a website

You wish to create a website based on one of the following business ideas:

- a hair salon
- online gaming
- gardening.

1. Select one of the options. Decide on a concept for your website and create a sketch of a homepage and at least two levels of detail in the structure.
2. Select one of the recommended free website builders and, if you have not done so already, then complete the free online registration.
3. Give the website a suitable name.
4. Select a design appropriate to the business idea.
5. Add at least two graphics, pictures or videos.
6. Create a hyperlink to link relevant text to content:
   - **a** in the same web page
   - **b** in another web page
   - **c** to an email address.
7. Preview the website and use the checklist to evaluate for user friendliness and that the content displays effectively.
8. Obtain permission from your instructor before publishing the website.

Multiple choice questions

1 An example of a browser is:
- **a** docs
- **b** forms
- **c** sheets
- **d** Chrome.

2 An e-commerce website:
- **a** is a standalone web page
- **b** receives online payments
- **c** stores resumes and portfolios for its users
- **d** stores articles, web pages and other content.

3 Browsers let you ___________ HTML files.
- **a** edit
- **b** view
- **c** create
- **d** delete.

4 The least commonly used browser is:
- **a** Edge
- **b** Opera
- **c** Firefox
- **d** Navigator.

5 The path a visitor would have taken to access a web page is called a:
- **a** list
- **b** web page
- **c** hyperlink
- **d** breadcrumb.

6 The current page in the path *Home / Water / Bottled / Reusable* is:
- **a** Home
- **b** Water
- **c** Bottled
- **d** Reusable.

7 The header of a web page usually contains:
- **a** summary information
- **b** a logo or company name
- **c** major sections of the web page
- **d** copyright, legal or privacy notices.

8 A bookmark can connect to any of the following, *except*:
- **a** HTML code
- **b** an email message
- **c** another web page, file or document
- **d** another position within the web page.

9 Usually, an orphan web page means there are no:
- **a** email addresses
- **b** titles on the web page
- **c** links connecting to other web pages
- **d** major sections on the web page.

10 The following are all examples of free online web services for creating websites, *except*:
- **a** Wix
- **b** Word
- **c** Weebly
- **d** Webnote.

Short answer questions

11 Nathan wants to use a special keyboard to play music at weddings.
- **a** State the name of a special keyboard that can play music.
- **b** A friend records a video of him playing music on the keyboard.
  - **i** Explain what type of input and output devices he should use for the recording.
  - **ii** State the name of a website where users can watch these videos.
- **c** Nathan decides to use a web page to advertise his music.
  - **i** Describe the category of web page that is most suitable for him to design.
  - **ii** Give one free online website that he could use.

12 He wants to name his website *Nathan's Speciality Music*, with links to samples of his music and videos of him playing. The main content provides the costs per hour and booking form, along with copyright information.

a Sketch a layout of the web page, showing the sections with the information.

b Nathan designed an online form for clients to make bookings (Fig 6.13). For each of the following, state the name of a suitable content control:

Fig 6.13

i Email address
ii Type of party
iii Day
iv Date of party
v Submit.

13 Write an example of a booking in the form for a children's party on Wednesday.

14 Explain what Nathan needs to do to transfer videos of his music to the web page.

15 Nathan clicks on a video on the web page to view it, but there is no sound. Explain a possible cause of this problem.

16 A few weeks later, Nathan sees his videos on another website advertised by someone else. Describe what type of computer system misuse has affected Nathan and his videos.

7.1 Introduction to spreadsheets

Spreadsheets are a particularly good choice of software when you want to work with numbers and display results in graphs. Spreadsheets are therefore widely used in finance-related tasks such as preparing budgets, payroll, financial statements and invoices. They also have advanced features such as 'what-if' analyses and forecast modelling that are useful in business.

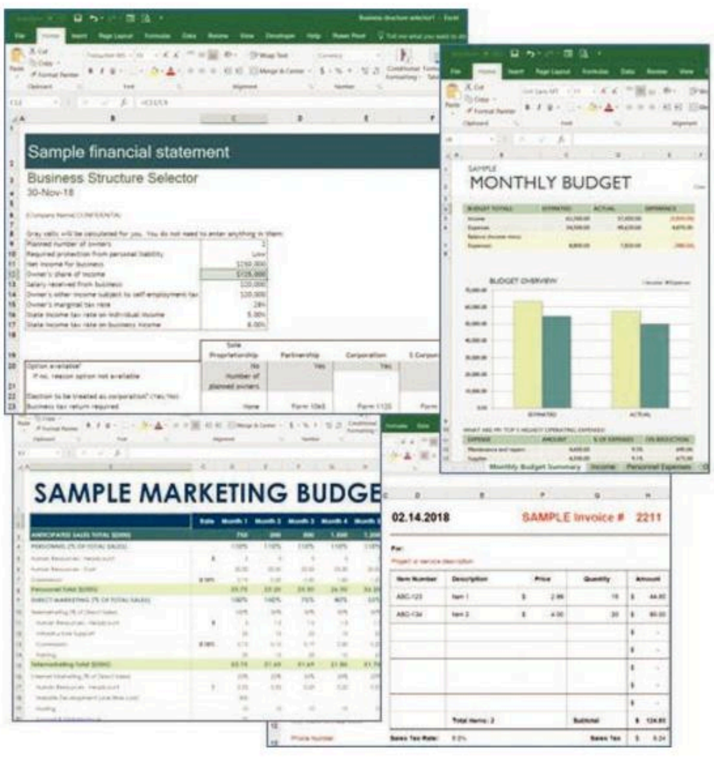


Fig 7.1 Samples of how spreadsheets can be used

A spreadsheet is a grid of cells organised in rows and columns (Fig 7.2). Each column is given a letter, and each row a number. This means that each cell has a unique reference identified by the column letter and row number. For example, B4 specifies the cell in column B and row 4. Look at the example in Figure 7.3. You will see how the spreadsheet is organised into rows and columns of cells. By clicking with the mouse, you can select individual cells or a range of cells. In this case, the single cell B4 has been selected.

	A	B	C
1	This is cell A1	This is cell B1	This is cell C1
2	This is cell A2	This is cell B2	This is cell C2
3	This is cell A3	This is cell B3	This is cell C3
4			

Fig 7.2 A spreadsheet is a grid of cells organised in rows and columns

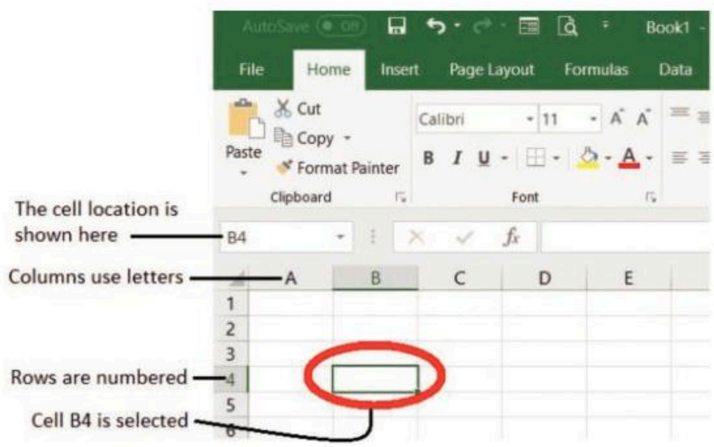


Fig 7.3 Each cell has a unique identifier. In this case, cell B4 has been selected

An extremely powerful feature of spreadsheets is the ability to enter formulae into cells. A **formula** is an equation that tells the spreadsheet what actions (calculations) you wish to take on any spreadsheet data. To enter a formula into a cell, you need to type the equals sign. Formulae often calculate how one cell relates to another. For example, to add together the values in cells A1 and A2, and show the result in cell B1, you would type in cell B1 the formula =A1+A2 (Fig 7.4).

The beauty of a spreadsheet is that a formula needs to be entered only once into a cell. In the example just given, the formula was entered into the cell B1. The values in cells A1 and A2 can easily be changed without affecting the formula. In fact, the formula can automatically recalculate the result. For example, if the value in cell A1 is changed to 100 and the value in cell A2 to 800, the new result – 900 – will automatically appear in cell B1. By simply changing the values in cells, and having the program automatically recalculate the result, spreadsheets allow you to perform 'what-if' calculations.

When entering a formula, you tell the spreadsheet what calculation to perform, for example adding, multiplying, dividing and subtracting by using operators such as plus (+), minus (–) and so on.

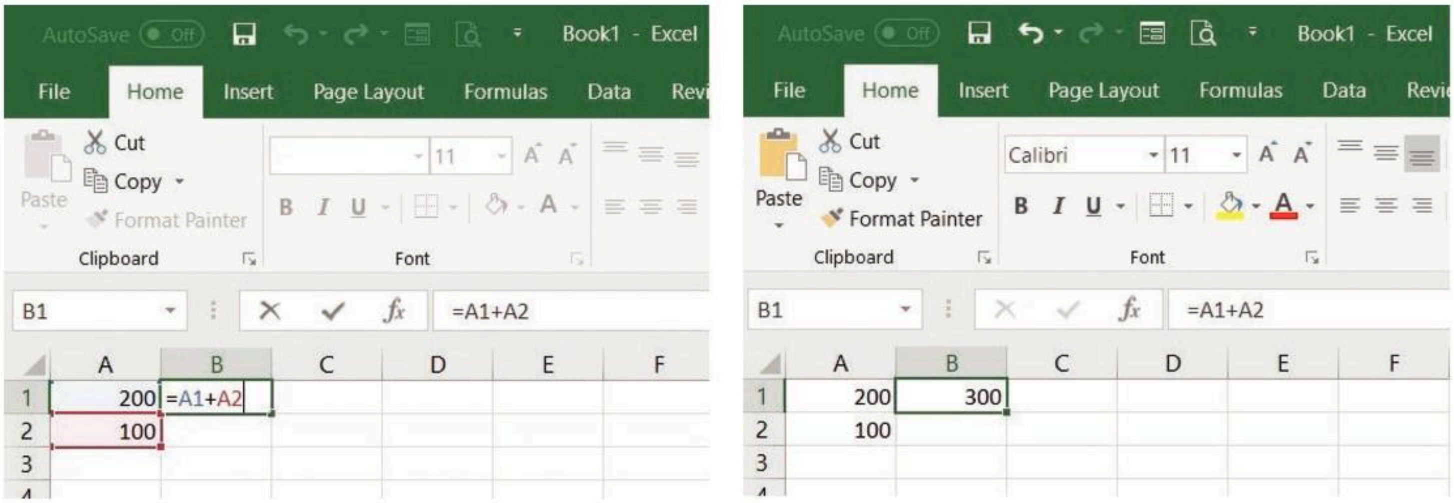


Fig 7.4 A formula is an equation that tells the spreadsheet what actions (calculations) you wish to take on any spreadsheet data. In this example, by entering the formula =A1+A2 into cell B1, the result (300) will automatically be calculated

Questions

1 List three examples to explain how spreadsheets are used.

2 Copy and fill in the blanks in the following sentences:

a A __________ is an application program that allows text, numbers and formulae to be entered into a grid of rectangular cells.

b In a spreadsheet, each __________ is given a letter, and each __________ a number.

c D12 specifies the cell in __________ D and __________ 12.

d To add together the values in cells A1 and A2, you would type the formula __________.

e To subtract the value in A2 from the value in A1, you would type the formula __________.

f Spreadsheets allow you to perform __________ calculations or __________ modelling.

g A popular spreadsheet program is __________.

3 If 33 was entered into cell B4 and 3 was entered into cell C4, write the formulae that would be used to:

a add (the contents of) cells B4 and C4

b multiply cell B4 by 2

c divide cell C4 by 3

d subtract cell B4 from cell C4.

4 Identify what each label in Figure 7.5 is showing.

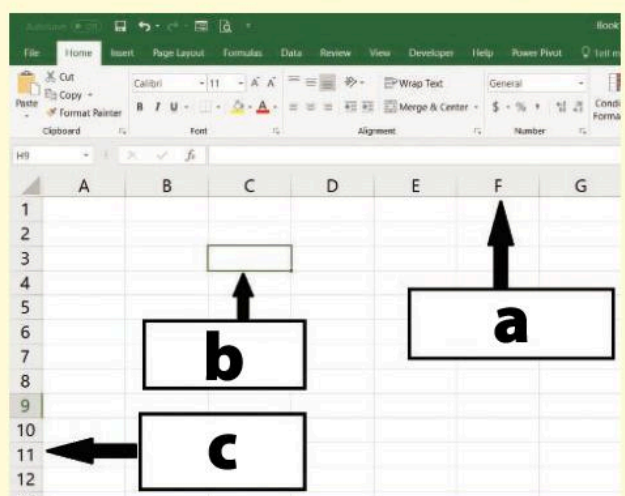


Fig 7.5 Diagram with labels for completion

People generally use the terms 'spreadsheet' and 'worksheet' interchangeably. However, to be consistent with Microsoft and other publishers we shall use the term 'worksheet' to mean the row-and-column sheet where you place your calculations, and the term 'spreadsheet' to mean the type of computer application or file, such as Excel.

Most of the Excel screen is devoted to the display of the workbook, which can contain one or more worksheets or chart sheets. We shall refer to 'sheets' to represent worksheets or chart sheets.

An Excel worksheet has over a million rows that extend down the worksheet, numbered from row 1. It has 16,384 columns that extend across the worksheet, lettered A to Z, AA to AZ, BA to BZ, and continuing to the last column. A workbook can contain a minimum of one sheet, and an unlimited number of sheets can be added. This is restricted only by the amount of memory available to store the Excel file.

Cells

Active cell

The active cell in the document window is highlighted with a darker border so you can tell where the cursor is located in the worksheet. You can move around the worksheet by using the arrow keys or with the vertical and horizontal scroll bars.

Once you have entered data into the active cell, Excel has several ways to complete a cell entry. These include:

- press *Enter*
- press *Tab*
- press *Shift* + *Tab*
- press an arrow key
- click another cell
- click the *Enter* button on the formula bar.

You can also edit a cell in various ways. First, make sure the cell is active. Then either:

- type over the cell's current contents. Note: the old data does not have to be deleted first; it is replaced by the new data
- double-click on it to modify its contents
- press the *Delete* key to erase it and type in new information.

Cell references

Cell references are the combination of column letter and row number. For example, the upper-left cell of a worksheet is A1. Examples of other cell references are Z25, BC304 and GG100.

Types of data

There are two types of data: labels and values. Labels are non-numeric data that a spreadsheet will not use in calculations, such as a person's name or an address. Values are numeric data which can be calculated.

Fig 7.6 Labels and values in a spreadsheet

Labels

In Excel any data that begins with a letter or includes a letter is defined as a label, for example 'Year' or 'Lastname'. Note that labels are left-aligned within the cell and cannot be included in numeric calculations.

Values

If the first thing you type in a cell is a number, Excel considers it to be a value. Note that values are right-aligned in cells and are used in calculations. For example, a sum of money would be considered a **value**. However, a telephone number would not be considered a value since this type of data is rarely used in calculations.

If you do not want a cell's numeric contents to be treated as a value, then the entry must begin with an apostrophe, or the cell can be formatted for text. This will prevent the number from being used in a numeric calculation. Examples of text format are a year (such as 2018), an identification number (such as 826045) or a telephone number (such as 111-2525).

Default displays

Default means that automatically, unless you specify otherwise, numeric data is always displayed in the right side of the cell. Non-numeric data (or text) is displayed in the left side of cells.

Formatting values and dates

Dates can be entered directly into cells. For example, if you enter Jan 31, 2018 in a cell, it will be formatted to a default format such as 31-Jan-18. Values can also be formatted for decimal placement, commas, dollar signs and so on, by selecting Cells from the Format menu.

Text alignment

Text alignment or justification is also common in a spreadsheet. The Formatting toolbar includes four buttons:

- Align Left
- Align Right
- Center
- Merge and Center.

The left, centre or right options align data within the cell. You can change alignment on a single cell or a block of cells. If the text or number is as wide as the cell, then changing the alignment has no effect.

The Merge and Center option is useful for centring headings. Select several cells, for example A1 through C1, and then click on the Merge & Center icon (Fig 7.7). The text in A1 will appear to be centred across the cells, although it is still located in cell A1 (Fig 7.8). For this feature to work correctly, the heading must be in the left-most cell in the block range.

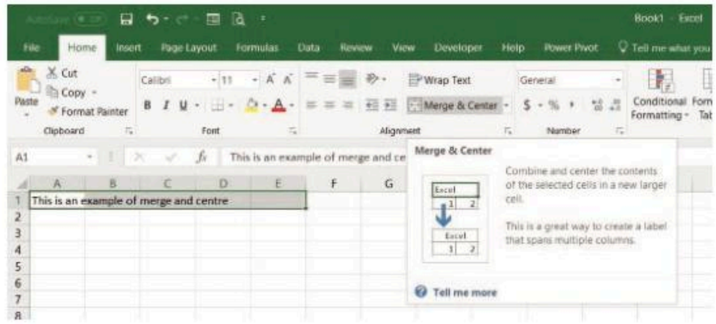


Fig 7.7 Merge and Center is a useful spreadsheet feature

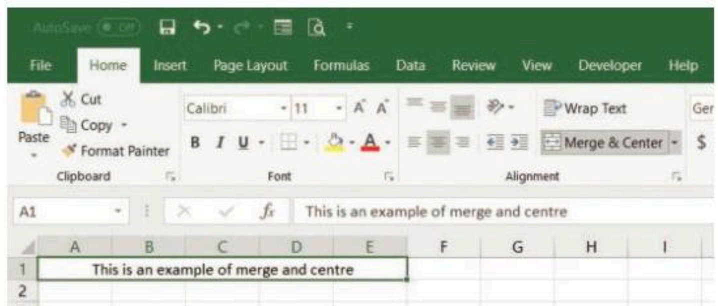


Fig 7.8 The text is still located in cell A1

Cut, copy and paste

The **Cut**, **Copy** and **Paste** commands operate consistently in all Microsoft applications. The Cut command removes the selected information and places that information on the clipboard. The clipboard is a storage space that temporarily holds information. This information may then be moved (pasted) to another location. Note that Excel copies the entire cell, including formulae and their resulting values, comments and cell formats.

Column widths and row heights

By default, all columns in Excel are 8.43 spaces wide, but can contain a width of up to 255 characters. If a column has a width of 0 (zero), then the column is hidden. Rows are typically 12.75 points high (approximately 1/6 inch or 0.4 cm), which is just the right size to fit the default font. A row can be as high as 409 points (almost 6 inches), but a height of 0 (zero) will hide the row. You will often need to change column widths and row heights. If a value is too big for a cell, your data will be displayed as '#####' (Fig 7.9). If your text is too long and the next cell also contains data, then only the first few letters of your text will be visible.

There are several ways of changing the size of the cells in Excel (Fig 7.10):

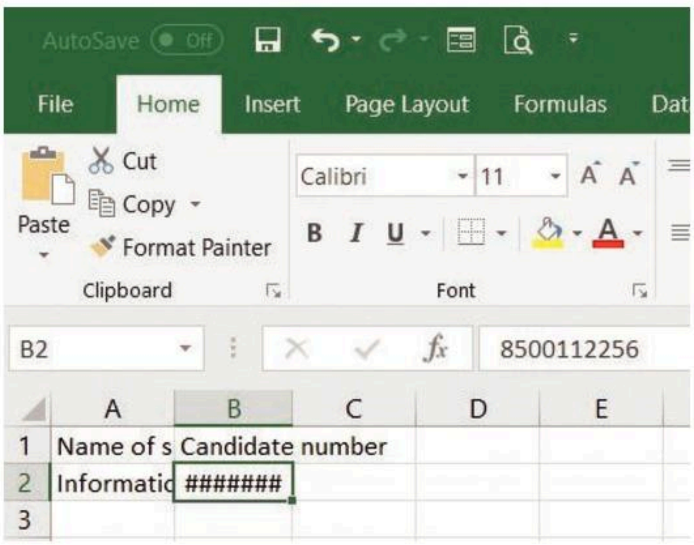


Fig 7.9 In this illustration, the text in cell A2 is too long while the value 8500112256 is too big for the cell

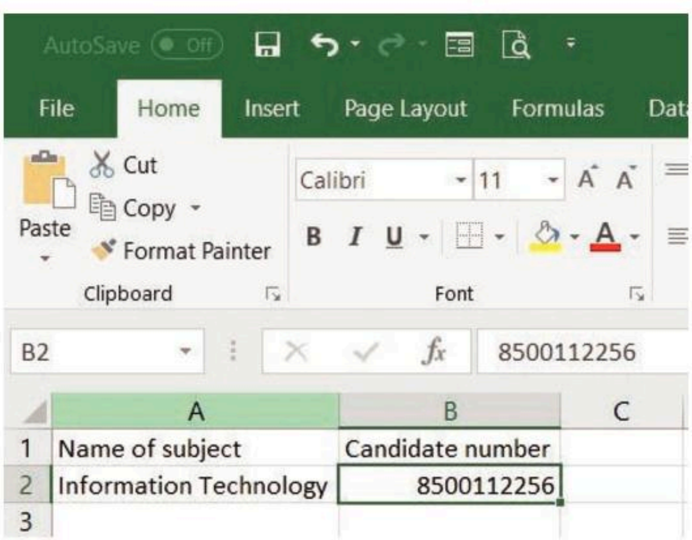


Fig 7.10 Adjusting the width of a cell to fit its contents

- Drag a column or row border to a different size.
- Double-click a column's right border to AutoFit the column. AutoFit means the column is widened to fit the largest cell entry.
- Double-click a row's bottom border to adjust the row height. The row is adjusted to the largest font size.
- From the Format menu choose Row, Height or Column, Width.

If the mouse is used to change the column width or row height, a screen tip appears that displays the current size.

Formulae and functions

When a formula is created, the result is displayed in the cell and the formula is displayed in the Formula Bar. If a number used in a formula changes, Excel will automatically recalculate the formula and a new result will be displayed.

To start a formula, enter an equals sign. Then enter the addresses of the cells to be used in the calculation. The arithmetic operators (Table 7.1) specify the arithmetic operation to use in the calculation.

Table 7.1 *Common arithmetic operators used in formulae*

Operator	Meaning	Example
+	Add	=A1+A2
–	Subtract	=A1–A2
*	Multiply	=A1*A2
/	Divide	=A1/A2
%	Percentage	There are different ways to do this. One way is as follows: to add 5% to the value of cell A1, you would enter =A5*(1+5%)

A formula can be keyed directly into a cell, or you can use the mouse to point to the cells you want to include. Formulae can also be copied by using the Copy and Paste buttons.

A **function** is defined as a built-in mathematical formula included in Excel. Functions are used for common calculations in business and personal use. Four common functions are:

- SUM: automatically totals a column or row
- AVERAGE: adds the values in the range and divides by the number of cells in the range
- MAX: used to determine the largest value in a range
- MIN: used to determine the smallest value in a range.

AutoFill

When you enter a formula that you need to copy to other cells, then the AutoFill feature will help you. The AutoFill command instructs Excel to copy cells, including formulae, functions from one selected cell, row or column to adjacent cells. You may also use AutoFill with text and numbers without formulae, such as months or actual numbers. Excel's AutoFill will fill a block of cells with either numbers or text depending on what is located in the first cell. Here are the steps:

1. Click on the cell with the data.
2. Move the mouse to the bottom right corner of the cell. The pointer should change to a thin crosshair (Fig 7.11).
3. Click and drag the mouse to fill the other cells (Fig 7.12).

When working with numbers, however, you must enter two cells of data so that Excel knows by how much the numbers should be increased each time.

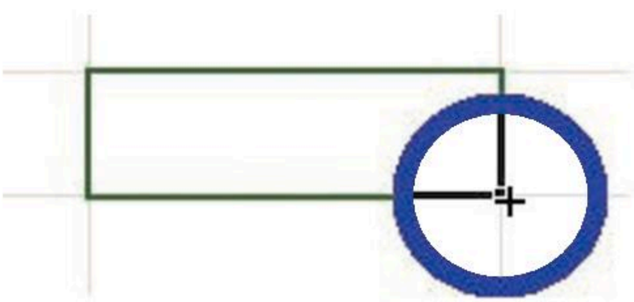


Fig 7.11 The Fill Handle is at the lower right corner of the cell

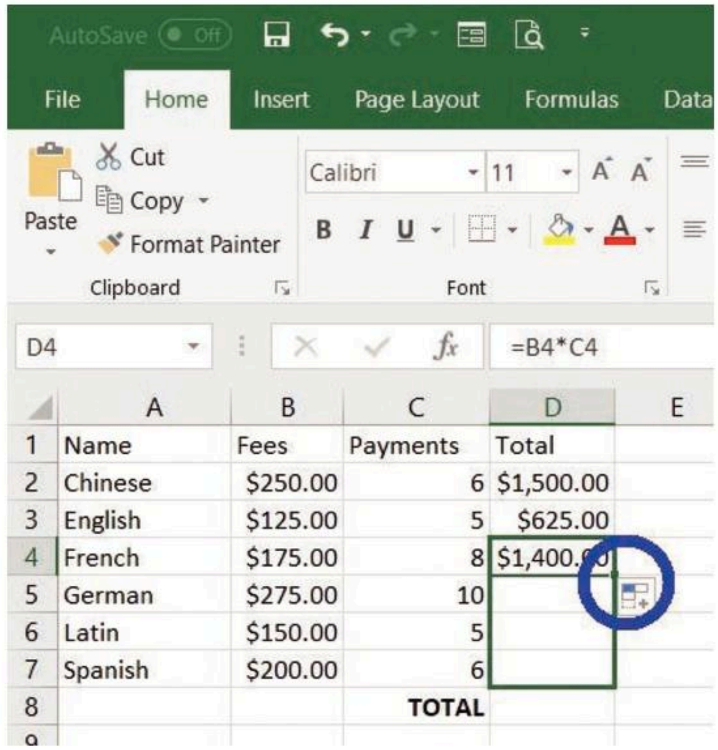


Fig 7.12 Place your mouse pointer on the Fill Handle at the lower right corner of the cell and drag down to auto fill the formula to the remainder of the cells

Cell ranges

Often while working in Excel, you may need to select more than one cell. A range is a group of cells that form a rectangle on the screen (Fig 7.13). In Excel there are several ways to select a range using the mouse:

- Drag across adjacent cells.
- Make the first cell of a range active, hold down the *Shift* key and click the last cell needed to complete the range.
- Use Edit/Select All or *Ctrl* + *A* if you need to select everything within a worksheet.
- Click on row headings (row number) to select an entire row.
- Click on column headings (column letter) to select an entire column.

Excel also has several ways to select cell ranges using the keyboard:

- *Shift* + *arrow* key: selects the active cell and moves in the direction of the arrow

Fig 7.13 To select a range of adjacent cells, click on the first cell and drag to highlight the other cells

Fig 7.14 If you have to use a range often, you should use the name box to name the range of data

- *Shift* + *Spacebar*: selects the current row
- *Ctrl* + *Spacebar*: selects the current column.

When you wish to select cells that are not adjacent, the procedure is just as simple:

- Press and hold the *Ctrl* key.
- Click one or more required cells, or row number or column letter.
- Release the *Ctrl* key.

Naming cell ranges

Your selected range produces an address which includes the upper-left cell address and the lower-right cell address, separated by a colon. In Figure 7.14 the range address of the selected cells is (A2:A7). If you have to use a range often, you should name the range: click in the name box, type a meaningful name, such as 'language' in Figure 7.14, and press *Enter*.

The idea of using range names is to make areas of the worksheet easier to work with. Just as you give a file a name that means something to you, so you should give ranges meaningful names. Once you have named a range, you can select it by clicking on the arrow next to the name box.

Here are a few rules to follow when naming a range:

- Range names must begin with a letter.
- Range names cannot have the same name as a cell address.
- Range names cannot contain spaces. Use uppercase first letters, an underscore or a fullstop to separate words.
- Range names cannot contain special characters such as hyphens, dollar signs, per cent signs, ampersands or number signs.
- Range names should contain less than 256 characters
- Keep in mind that the idea of using range names is for identification. Use names that are simple, yet recognisable or related to the data they represent.

Title locking

Rows and columns in a spreadsheet can be locked (fixed or 'frozen') so that they remain on the screen and do not scroll when you scroll around a sheet. Locked rows remain stationary when you perform vertical scrolling, whereas locked columns remain stationary when you perform horizontal scrolling. Locking both rows and columns allow you to place titles in your spreadsheet that are always displayed.

Data contained in fixed rows and columns cannot be edited. You must perform any data editing in these rows and columns before you fix them. If you try to select a cell in a fixed row or column, the entire row or column is selected, just as if you selected a row or column heading.

Freezing a horizontal set of data

- Select the row directly beneath the section that you want to remain visible (Fig 7.15).
- Select View on the Menu bar.
- Select Freeze Panes.

- Select Freeze Top Row to lock the first row only.

Freezing a vertical set of data

- Select the column immediately to the right of the section that you want to remain visible.
- Select View on the Menu bar.
- Select Freeze Panes.
- Select Freeze First Column.

Freezing both horizontal and vertical data

- Select the cell beneath and to the right of the section that you want to remain visible.
- Select View on the Menu bar.
- Select Freeze Panes.
- Select Freeze Panes again from the list.

Removing frozen headings

- Select View on the Menu bar.
- Select Unfreeze Panes.

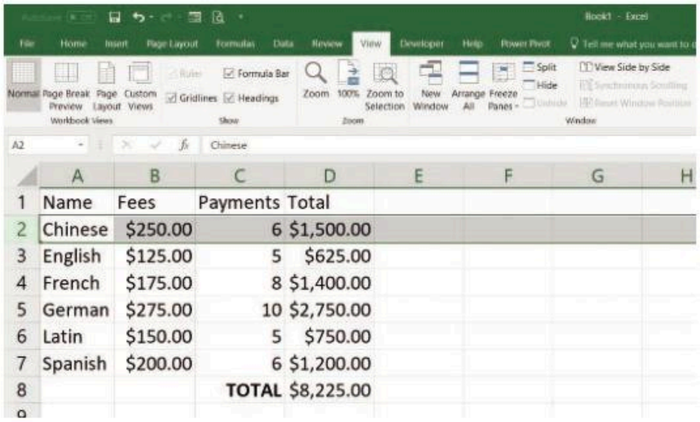


Fig 7.15 Select the row below the row you want to freeze

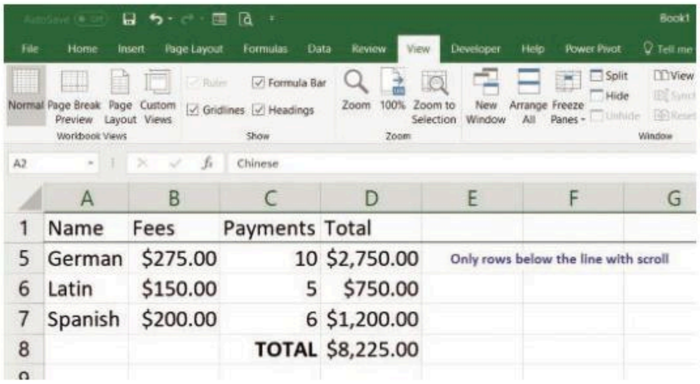


Fig. 7.16 The column headings now stay at the top even when you scroll through the rest of the data

Questions

1 Explain the similarity or differences between a workbook, a worksheet and a spreadsheet.

2 For each of the following, state whether it is a function or a formula:
=SUM(B1:G4)
=E3*5%
=MAX(E4:E6)
=(E6-E4)*10
=MIN(C1:C10)
=AVERAGE(B1:C9)
=H2/3

3 Explain why it is useful to name a range of data.

4 Answer the following questions based on information for dance lessons as shown in Figure 7.17.

a Identify the name of the feature used in row 1.

b Identify the active cell.

c State the letter for a column that contains a value.

d State a row number that does not contain a value.

e State the justification used in:
i cell A5 **ii** cell D6.

f Write the range of cells that contain the times for the dance lessons.

	A	B	C	D	E	F
1	Schedule for Summer					
2	Class	Days	Time	Cost ($)	Limit	Total
3	Classical	Tue	5pm	150	20	$3,000
4	Hiphop	Wed	7pm	200	30	$6,000
5	Jazz	Sat	10am	250	15	$3,750
6	Latin	Fri	7pm	300	35	#####
7			TOTAL	900	100	#####

Fig 7.17 Spreadsheet for Question 6

g Write the name of the appropriate function for cell E7.

h State the name of the function that should be used to calculate:
i the lowest limit **ii** the highest cost.

i Explain why cells F6 and F7 are displayed as shown in the figure and describe how it can be corrected.

j State whether each of the following instructions can be achieved:
i freeze row 1
ii freeze column A
iii freeze row 1 and column A
iv freeze row 2
v freeze row 2 and column B.

As with other computer applications, the best results come from thinking about the task in hand. When planning a worksheet, ask yourself the following four questions:

1 What is the goal of the worksheet?
2 What are the desired results (outputs)?
3 What data is needed to calculate the results (inputs)?
4 What calculations are needed to produce the desired results?

Sometimes a spreadsheet is created to solve a problem for just one user and is never used again. It is set up quickly to get some result, but the appearance is not important. No one other than the creator of the worksheet will see it since it will only be used once. The creator of such a spreadsheet would still consider the four questions above, just not in a structured way.

Another form of worksheet is one that will be used many times, but only its creator will be using it. So the author will take a little more time with the above questions and the layout and appearance of the spreadsheet will probably be better.

The final category of spreadsheet is one set up for someone else. More time must be taken to answer the above questions, and the spreadsheet will need good design and good documentation. Since other people will have access to this spreadsheet, the creator of the worksheet may have to meet with these users many times so that they can make suggestions and approve it until it is finalised.

Arithmetic formulae

If you have many operators in a formula, it is important to follow the rules for the order of operators. You have probably come across the mnemonic **'BODMAS'** in maths. The first letter of each word stands for the operator:

- **B**rackets (parentheses) take precedence over any other operator. The computer must calculate the part of the formula in brackets first.
- **O**rder means anything raised to the power of a number, such as 2^2.
- **D**ivision and **M**ultiplication are calculated next, in the order left to right as they appear in the formula.
- **A**ddition and **S**ubtraction are the last two operations to be carried out. Again, these are calculated in order as they appear from left to right in the formula.

In a spreadsheet, formulae are used to calculate answers based on mathematical equations that you create. When creating formulae, you may use:

- actual values (=7*5)
- cell addresses (=C4+D4+B25)
- a combination of the two (=C17*8).

To enter a formula:

1 Click the cell where you want to insert the formula.
2 Press the equals sign.
3 Enter the formula.
4 Press *Enter*.

Functions

Functions are a powerful part of Excel. The syntax or structure of a function is:

> the equal sign, the function name, an open bracket, one or more arguments (for most functions) and a closed bracket.
>
> = *function name* (*one or more arguments*)

An argument is mostly a cell reference, a range of cells or a constant (number). There are some functions that do not use arguments, but you still need the open and closed brackets. The number of arguments will vary in different functions. The following examples illustrate some frequently used functions.

AVERAGE

The AVERAGE function calculates the average of a range of cells.

The syntax is =AVERAGE(*range of cells*)

As an example, if you were to enter into cells B3, B4, B5, B6 and B7 how much money you spend on lunch each day for a week, this function can be used to calculate your average daily spending.

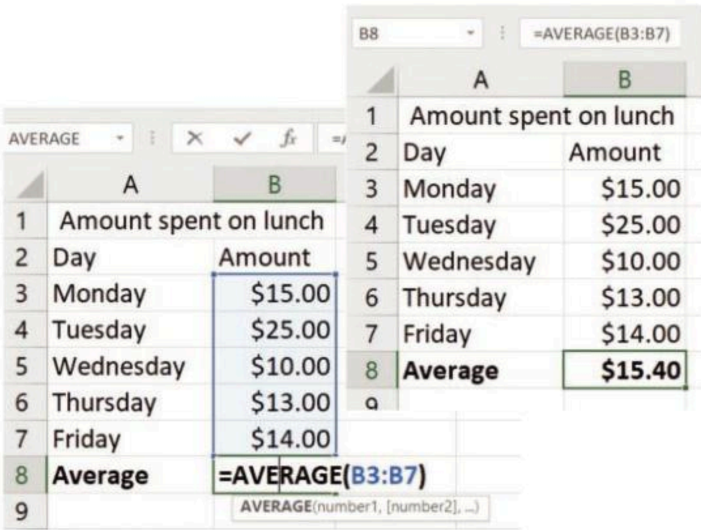


Fig 7.18 Using the Average function to estimate daily spending

COUNTA and COUNT

The syntax is =COUNTA(*range of cells*) and =COUNT(*range of cells*)

These functions count the number of cells in a range. Notice that COUNT counts the numbers in a range while COUNTA counts numbers but also other data such as text or non-blank cells in the range.

Suppose you and some members of your class volunteered to collect money for charity. You enter the contributions collected into cells C1 to C4. Then you can use the COUNT function to count the number of contributions received (Fig 7.19). There is also the COUNTA function which counts the number of cells in a range that are not blank or may contain text (Fig 7.20).

COUNTIF

The syntax is =COUNTIF(*range of cells*, *criteria*)

This function counts the number of cells that meet given criteria.

In Figure 7.21, the function =COUNTIF(B3:B6,"<10") is used to count how many classmates donated less than $10. Notice that only two students donated less than $10 because the function did not include the option for donating exactly $10.

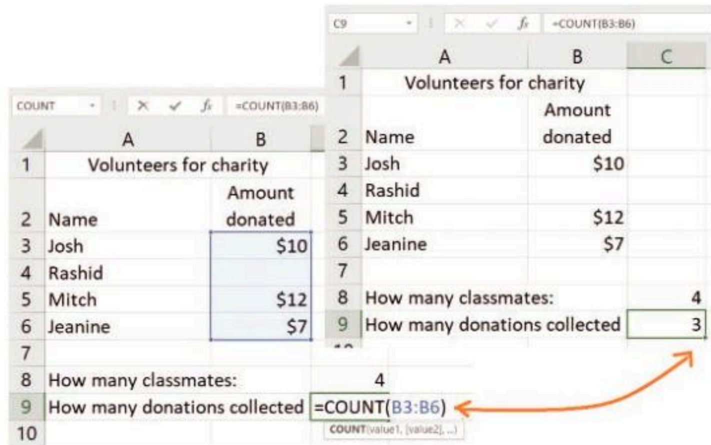


Fig 7.19 Using the COUNT function to determine how many collections were made

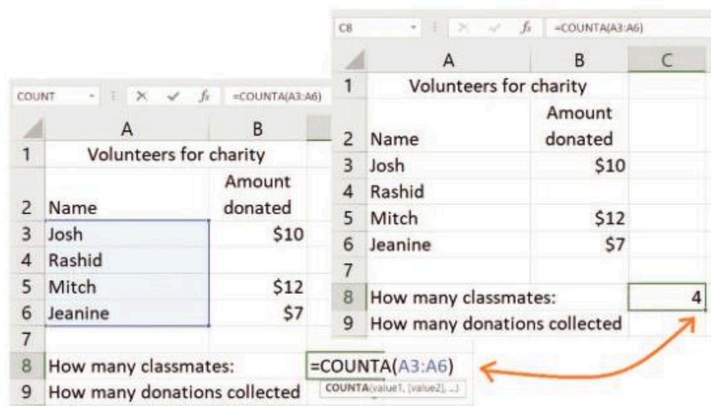


Fig 7.20 Using the COUNTA function to determine how many classmates volunteered

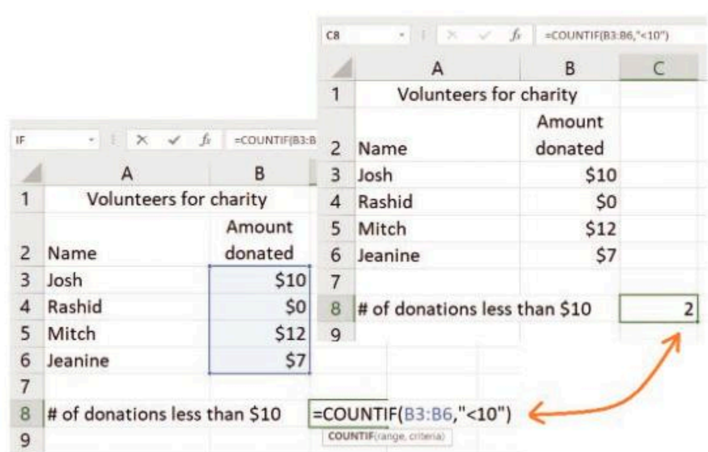


Fig 7.21 The COUNTIF function uses given criteria when counting within a range of data

DATE

The syntax is =DATE(*year, month, day*)

This function combines values in three cells to produce a date. For example, if cell A1 contained the number 12, cell A2 contained the number 5 and cell A3 contained the number 2020, then =DATE(A3,A2,A1) produces 5/12/2020 or Tuesday, May 12, 2020. Alternatively, =DATE(A3,A1,A2) produces 12/5/2020 or Saturday, December 5, 2020. Make sure that the cell containing the function is formatted to display the date as you want to display it.

Apart from the DATE function, another useful function is =TODAY() returns the current date. Note there is no space or text between the brackets in this function.

IF

The syntax is =IF(*logical test*, *value if true*, *value if false*)

This function allows you to make a choice depending on whether a condition is met or not and returns one of two values.

Suppose you have decided that if you spend an average or more than $10 on lunch, then you should make your own lunch the next week. The IF statement is useful to determine whether you should continue to buy lunch or make your own lunch.

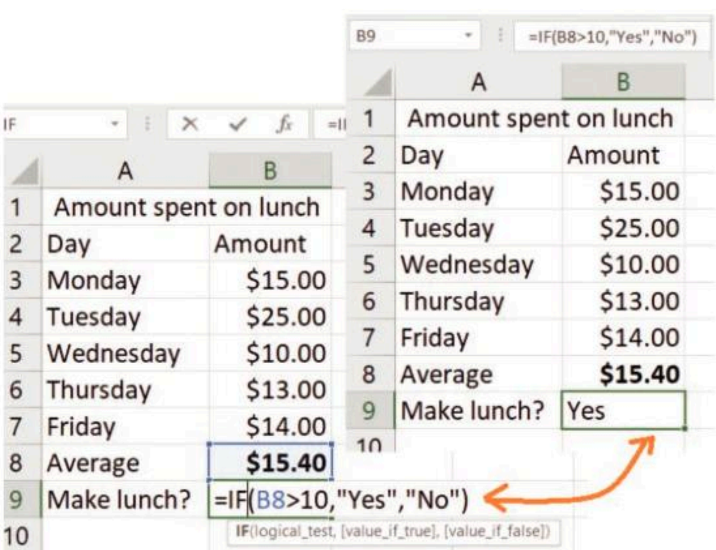


Fig 7.22 illustrates how the IF statement determines the outcome if the average amount spent on lunch is more than $10

MAX

The syntax is =MAX(*range of cells*)

The MAX function produces the largest or maximum value in a range of cells.

Using the student volunteer example in Figure 7.19, the largest donation can be found by entering =MAX(B3:B6)

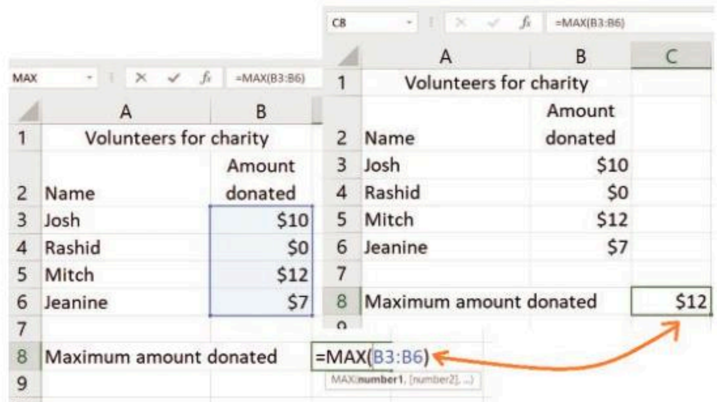


Fig 7.23 The MAX function finds the largest donation

MIN

The syntax is =MIN(*range of cells*)

To complement the MAX function, the MIN function produces the smallest or minimum value in a range of cells. Figure 7.24 shows the least amount of money donated.

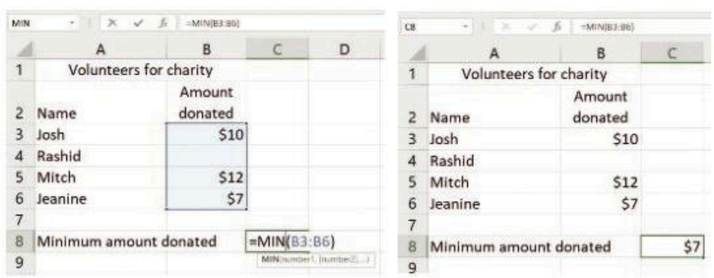


Fig 7.24 The MIN function finds the smallest donation

PMT

The syntax is =PMT(*interest rate*, *number of payments*, *loan amount*)

The PMT function is a financial function that is used to calculate the payment for a loan based on a specific number of payments and a constant interest rate. If the repayments are made on a monthly basis, then the yearly interest rate and the number of payments need to be converted to frequency of payment. To do so, the interest rate must be divided by 12, while the number of payments should by multiplied by 12 if they are quoted in years.

Figure 7.25 illustrates a $5000 loan with a yearly interest rate of 7.65% that must be repaid in two years. This means that the monthly interest rate is B2/12, and the number of repayments is calculated at 2 years × 12 months = 24 payments or B3*12. The loan function is therefore =PMT(B2/12,B3*12,B1) returning a payment of $225.34 per month over the two years. You may note that the result is a negative value representing an outgoing payment from the person who is repaying the loan.

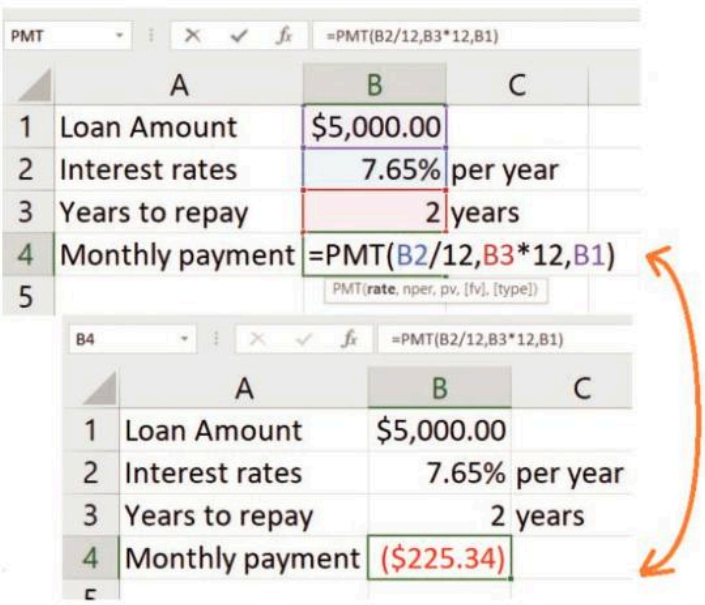


Fig 7.25 The PMT function calculates payments on a loan

RANK

The syntax is =RANK(*number whose rank you want to find, range of numbers, order of rank*)

In later versions of Excel this function has been renamed to RANK.EQ.

The syntax is =RANK.EQ(*number whose rank you want to find, range of numbers, order of rank*)

This function produces the position of a number or item in a sorted list, so that the first item would have a rank of 1 (see section 7.5 for more on sorting data). Note that duplicate numbers are given the same rank.

Figure 7.26 illustrates how the final positions are determined in a closely contested sports race with six athletes. The range of data from A2 to A7 and B2 to B7 are first sorted as a group by the finish times in ascending order, so that the person with the fastest time is at the top of the list. The cell range B2:B7 is named racetimes. In cell C2 type =RANK(B2,racetimes,1) and press *Enter*. The number 1 in the function indicates that the list is in ascending order, while 0 or omitting a number indicates that it is descending. The rank of the first athlete, Matt, is =RANK(B2,racetimes,1) and shows the value 1, which is first or rank 1. Copy the function to the remainder of cells in C3:C7. Excel adjusts the cell references appropriately. The next rank =RANK(B3,racetimes,1) = 2 for Eli. However, note that Rich =RANK(B4,racetimes,1) = 2 since he has the same finish time as Eli, and is therefore also ranked as position 2. Position 3 is skipped because of the tied rank, and so Ole would be in 4th position.

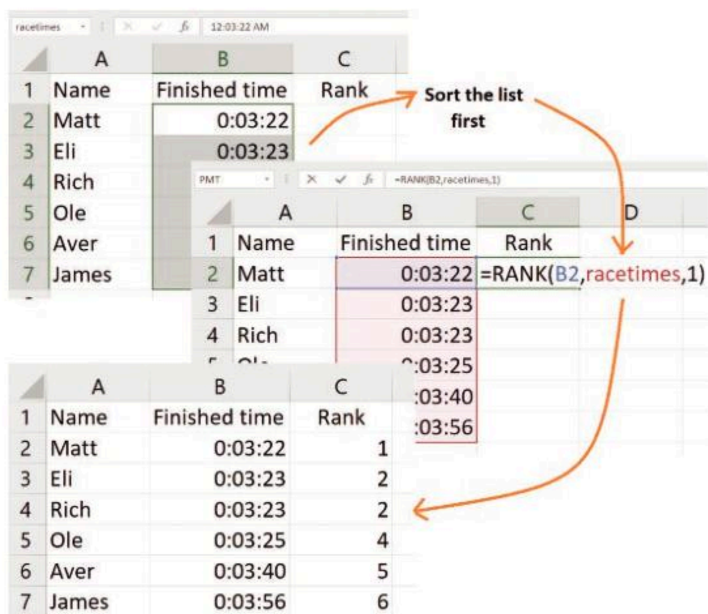


Fig 7.26 In this example the RANK or RANK.EQ function is applied to determine final results of competitions

SUM

The syntax is =SUM(*range of cells*)

If you wanted to add together the numbers in cells B1 to B175 you could use the + operator to add the cells (B1+B2+B3, etc.). This would take you a long time!

It is much quicker, and easier, to use the SUM function. The SUM function can be used in four ways:

- adding values, for example =SUM(1,4,9)
- adding cell references, for example =SUM(B3,C3,F4)
- adding ranges of values, for example =SUMC3:C10)
- adding a combination of the above options, for example =SUM(B3,C4:C10,12)

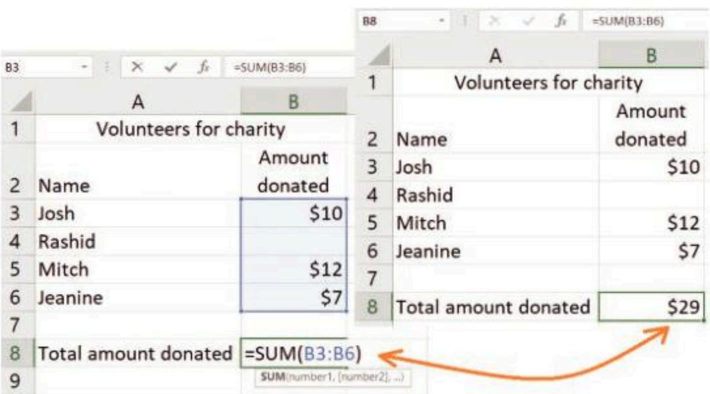


Fig 7.27 illustrates the calculation of total donations using SUM

VLOOKUP

The syntax is =VLOOKUP(*value you want to look up, the range of data where the value is located in the first column, the column number relative to the first column containing the additional information you need, whether the list in the first column of the range is sorted or not sorted*)

VLOOKUP searches the first column in a table of data for a value. If the value is found, any other value in that row can be selected. The V in VLOOKUP represents looking vertically down the first column.

An example of performing a lookup could be searching for grades on a list pinned on a noticeboard. The list is searched vertically until the correct ID number or name is located. Then the associated row is searched until the grade is found. The function in Figure 7.28 is similar to those steps. The function =VLOOKUP(B8,class,2,FALSE) searches the first column in a range named class (for the Jazz class), and then searches across the row to column 2 for the day of the class. The list of classes is not sorted, so 'false' is entered at the end of the function. The day returned is Saturday. The function =VLOOKUP(B8,class,3,FALSE) would return 10am as the time of the class. The column number is changed to return another set of data based on the class.

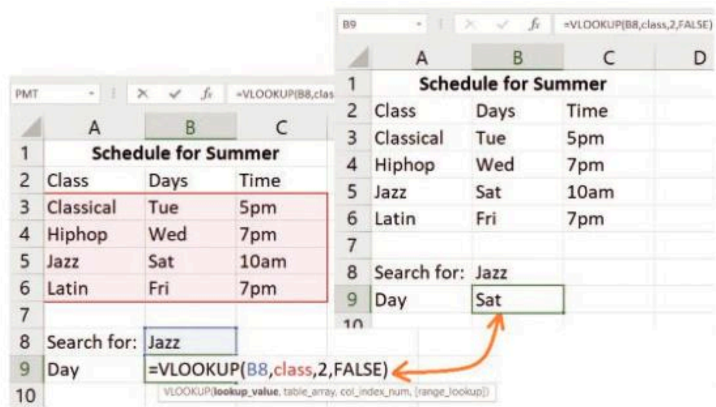
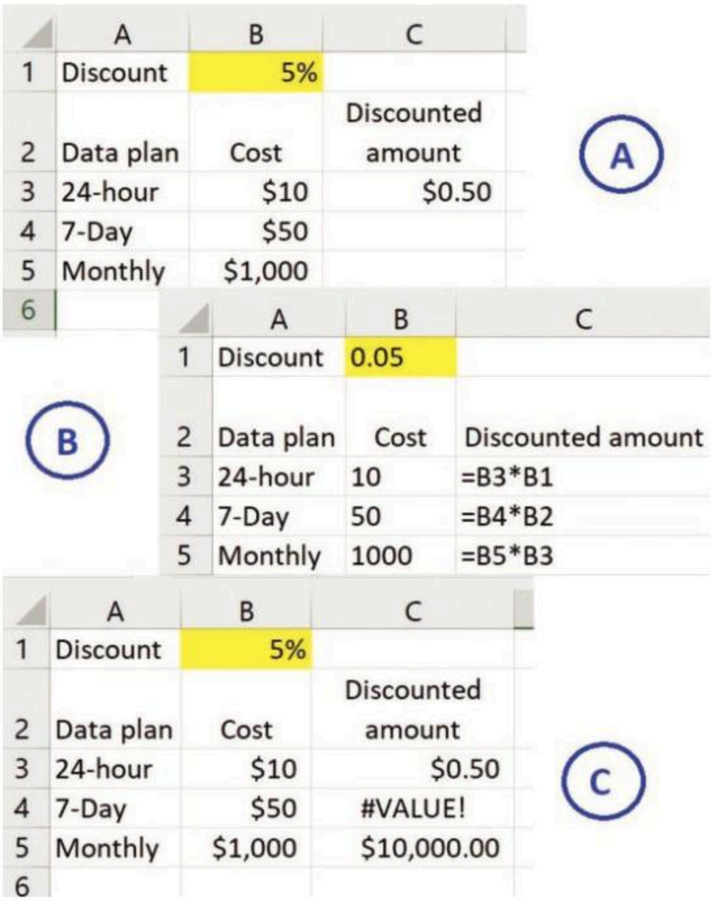


Fig 7.28 VLOOKUP is useful when searching for information in large tables

Relative and absolute addressing

Copying formulae can be extremely useful.

Consider the spreadsheet shown in Figure 7.29A, where a 5% discount is calculated on three data plans. As you create a spreadsheet to automatically work out the discount on each plan, you want to copy the formula to other cells and keep the discount as it is. The formula in cell C3 is =B3*B1. If cell C3 containing the formula is copied to cells C4 and C5, Figure 7.29B shows the resulting formulae. This adjustment of a formula when copied to other cells is an example of Excel using relative addressing. This assumption by Excel (in this case using the cell to the left and the one two above it each time) is useful sometimes but does not help if you need to refer to an exact location on the sheet each time, such as your discount value cell in B1. This explains why the copied cells return an error or the result is incorrect (Figure 7.29C).



A

	A	B	C
1	Discount	5%	
2	Data plan	Cost	Discounted amount
3	24-hour	$10	$0.50
4	7-Day	$50	
5	Monthly	$1,000	
6			

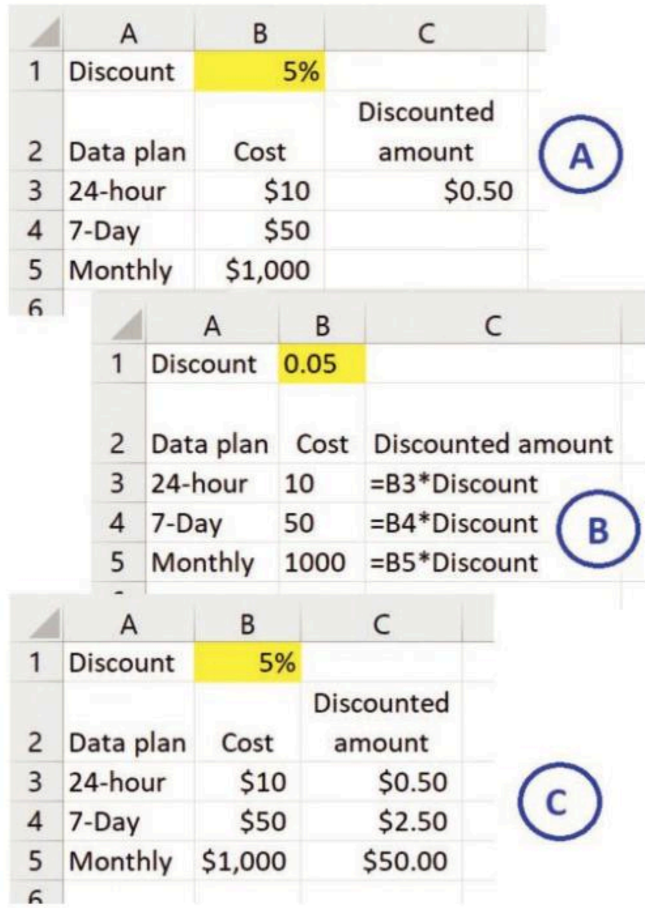
B

	A	B	C
1	Discount	0.05	
2	Data plan	Cost	Discounted amount
3	24-hour	10	=B3*B1
4	7-Day	50	=B4*B2
5	Monthly	1000	=B5*B3

C

	A	B	C
1	Discount	5%	
2	Data plan	Cost	Discounted amount
3	24-hour	$10	$0.50
4	7-Day	$50	#VALUE!
5	Monthly	$1,000	$10,000.00
6			

Fig 7.29 Copying formulae can sometimes give the wrong result



A

	A	B	C
1	Discount	5%	
2	Data plan	Cost	Discounted amount
3	24-hour	$10	$0.50
4	7-Day	$50	
5	Monthly	$1,000	

B

	A	B	C
1	Discount	0.05	
2	Data plan	Cost	Discounted amount
3	24-hour	10	=B3*Discount
4	7-Day	50	=B4*Discount
5	Monthly	1000	=B5*Discount

C

	A	B	C
1	Discount	5%	
2	Data plan	Cost	Discounted amount
3	24-hour	$10	$0.50
4	7-Day	$50	$2.50
5	Monthly	$1,000	$50.00

Fig 7.30 Naming a cell is useful for certain calculations

Without naming one or more cells (absolute referencing), the formula might not work when copied to other cells, as shown in Figure 7.30. Therefore, you should name the cell containing the 5% discount (B1). To illustrate this, use the name box in the top left corner of the spreadsheet to name cell B1 as Discount. As the cells are copied down to cells C4 and C5, the results use absolute addressing to multiply the 5% discount in cell B1 with the correct costs in B4 and B5 for C4 and C5.

Manipulating rows and columns

Sometimes you may forget to insert one or more columns and/or rows in a table. However, you do not have to start over, because spreadsheets have a function that allows you to insert rows or columns or both. Excel also usually manages to adjust any cell references in formulae in your sheet to compensate for the change.

When you add a row, all rows will automatically move down one row. For example, in Figure 7.31, if you wish to insert a row above the word 'German' (fifth row), you must insert a new row at the fifth row. The fifth row, and everything in it, will become the sixth row, and so on.

A5 | German

	A	B	C	D	E
1	**Name**	**Fees**	**Payments**	**Total**	
2	Chinese	$ 250.00	6	$1,500.00	
3	English	$ 125.00	5	$625.00	
4	French	$ 175.00	8	$1,400.00	
5	German	$ 275.00	10	$2,750.00	
6	Latin	$ 150.00	5	$750.00	
7	Spanish	$ 200.00	6	$1,200.00	
8			**TOTAL**	$8,225.00	
9					

Fig 7.31 To insert a row above the word 'German' (fifth row), you must insert a new row at the fifth row

Inserting a row or column offers four choices (Fig 7.32):

- *Shift cells right:* Moves the contents of one or several cells to the right. The contents of the other cells in the column are not affected. The contents of the cells located to the right of the cell being moved will also move to the right.
- *Shift cells down:* Moves the contents of one or several cells down. The other cells in the row are not affected. The contents of the cells in that column below the cell being moved will also move down.
- *Entire row:* Inserts a row where the cursor is located. The entire row is moved down, not just one cell (the newly inserted row appears above the selected row).
- *Entire column:* Inserts a column where the cursor is located. The entire column (not just one cell) is moved to the right (the newly inserted column now appears to the left side of the selected column).

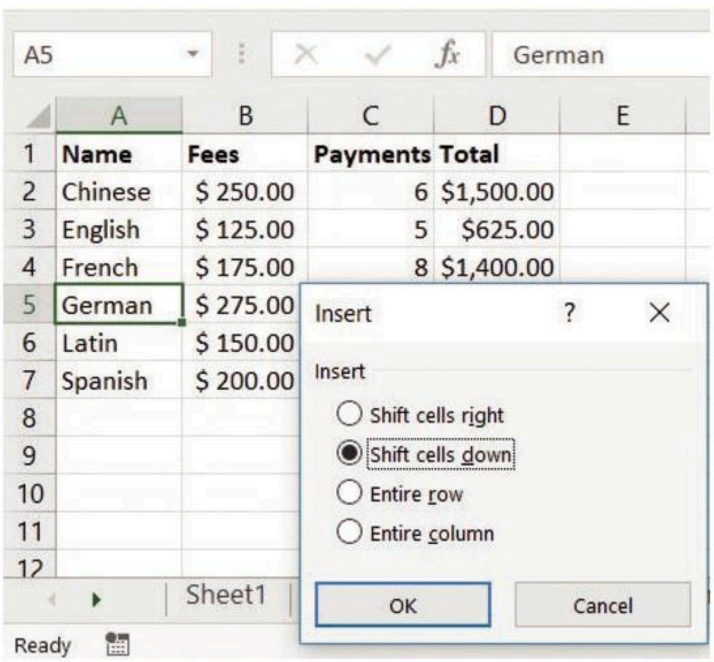


Fig 7.32 Inserting a row or column offers four choices

Deleting a cell, column or row also offers four choices (Fig 7.33):

- *Shift cells left:* Moves the contents of one or several cells to the left. The contents of the other cells in the column are not affected. The contents of the cells located to the right of the cell being moved will also move to the left.
- *Shift cells up:* Moves the contents of one or several cells up. The other cells in the row are not affected.
- *Entire row:* Deletes a row where the cursor is located. The row below the one deleted is moved up, not just one cell.
- *Entire column:* Deletes a column where the cursor is located. The entire column (not just one cell) is deleted and the column to the right is moved to the left to fill the column deleted.

Fig 7.33 Deleting a row or column offers four choices

Questions

Use Figure 7.34 to answer the following questions.

I8

	A	B	C	D	E	F	G
1			Schedule for Summer				
2	Class	Days	Time	Cost ($)	Limit	Total	# of calls
3	Classical	Tue	5pm	150	20	$3,000	25
4	Hiphop	Wed	7pm	200	30	$6,000	81
5	Jazz	Sat	10am	250	15	$3,750	61
6	Latin	Fri	7pm	300	35	$10,500	22
7			TOTAL	900	100	$23,250	

Fig 7.34 Spreadsheet showing schedule for summer classes

1 Identify the name box on the figure.

2 Write the formula that would be entered in cell F4.

3 If =F3*10% calculates the amount donated to charity from the Classical class, write the formula for the amount donated from the Hiphop class.

4 10% is now entered in cell H1 which is named CHARITY. Write the formula for the amount donated from the Latin class.

5 Explain the steps to add a column to the left of the Limit column.

6 Write complete functions to calculate the following:

- **a** the lowest cost
- **b** the average limit
- **c** the number of classes offered.

7 Write an IF statement in cell I3 to output the word CANCEL if the number of calls is less than 30, otherwise output a blank space.

8 If the function in cell I3 is copied to cells I4 to I6, then state the cells that would display the word CANCEL.

9 Write an IF statement in cell J3 to output the name of the class if the number of calls is less than the limit for the class, otherwise output the number of calls.

10 If the function in cell J3 is copied to cells J4 to J6, then write the output for that column.

11 State the location of the data in cell D5 after each of the following:

- **a** inserting a column at column B
- **b** inserting a row at row 5
- **c** deleting a column at column G
- **d** deleting a row at row 6.

Practical exercises using Microsoft Excel

Exercise 1: Creating a spreadsheet

1. Type the following data in Sheet1.
2. Merge the heading containing the title 'Donations collected' across columns A to B.
3. Double-click on Sheet1 (you find this on the tab at the bottom left) and rename it as MAIN.
4. Highlight the headings in row 3 and make them bold.
5. Save the spreadsheet as DONATIONS.

	A	B	C	D	E	F
1	**Donations collected**				Required	4000
2						
3	**Item**	**Received**	**Shipping date**	**Shipped**	**Transport type**	**More needed?**
4	*Water*	12000	02/09/2019	8000	Air	
5	*Tin food*	4950	03/09/2019	3500	Sea	
6	*Dry goods*	9870	06/09/2019	6500	Sea	
7	*Medical supplies*	1150	10/09/2019	1000	Air	
9	*Tarpaulins*	3500	15/09/2019	2500	Sea	

Sheet: MAIN

Exercise 2: Using functions

Use the MAIN sheet to continue this exercise.

1. In cell A10, type 'Total quantity of donations'.
2. Widen column A to fit the title in cell A10.
3. In cell B10, type =SUM(B4:B8) and press *Enter*.
4. Insert a row at row 6 and enter data for another donation: 5000 tins of baby formula were donated, but only 3000 can be shipped via Air on 06/09/2019.
5. In cell A12, type 'Total quantity of items shipped'.
6. In cell B12, type =SUM(D4:D9) and press *Enter*.
7. In cell A13, type 'Smallest quantity'.
8. In cell B13, type =MIN(B4:B9) and press *Enter*.
9. In cell A14, type 'Largest quantity'.
10. In cell B14, type =MAX(B4:B9) and press *Enter*.
11. In cell A15, type 'Types of items donated'.
12. In cell B15, type =COUNTA(A4:A9) and press *Enter*.
13. In cell A16, type 'Number of items shipped by Air'.
14. In cell B16, type =COUNTIF(E4:E9,"Air") and press *Enter*.
15. In cell A17, type 'Average quantities shipped'.
16. In cell B17, type =AVERAGE(D4:D9) and press *Enter*.
17. Use the name box to name cell F1 as QTY.
18. In cell F4, type =IF(B4<QTY,QTY-B4,"").
19. Use the AutoFill feature to copy the function in cell F4 to cells F5:F9.
20. Insert a row at row 8 and enter data for another donation: 8650 torches were donated, with 7000 shipped via Air on 10/09/2019.
21. Use the AutoFill feature to copy the function in cell F7 and paste it in cell F8.
22. A total of 3250 sets of medical supplies have now been donated. Update the spreadsheet with this data.
23. A loan of $30,000 was used to manage the donations collected and pay staff. The interest rate is 7.25% and the repayment time is 5 years. Type the following data in the same MAIN Sheet, starting at column J.

	J	K
1		
2		
3	*Loan Amount*	30000
4	*Interest*	7.25%
5	*Years*	5
6	*Repayment*	
7		
8		

24. In cell K6, type =PMT(K4/12,K5*12,K3)
25. Save the spreadsheet again.

Exercise 3: Using formulae

1. Type the following data in a new sheet of the DONATIONS spreadsheet.

	A	B	C	D	E	F
1	**Costs per day**					
2						15%
3	**Job code**	**Service**	**Cost**	**Quantity**	**Total cost**	**Discount**
4	FL	*Fuel/gal*	3.75	5000		
5	LC	*Landing charge*	1275	6		
6	SF	*Storage facilities*	2050	5		
7	PT	*Port fees*	2250	6		
8						

Sheet: EXPENSES

2. Rename Sheet2 as EXPENSES.
3. In cell E4, type =C4*D4.
4. Use the AutoFill feature to drag the formula from cell E4 to cells E5:E7.
5. Use the Name Box to name cell F2 as DISK.

6 In cell F4 enter a formula to calculate a discount of 15% on each service. Type =E4*DISK
7 Use the AutoFill feature to drag the formula from cell F4 to cells F5:F7.
8 Format the cells in the Cost, Total cost and Discount columns for currency with two decimal places.
9 Update cell F2 by changing 15% to 12%.
10 Name the range A4:C7 as SERVICE.
11 Save the spreadsheet again.

Exercise 4: Reviewing functions

Use the EXPENSES sheet to continue this exercise.

1 In cells E10, E11 and E12, enter appropriate functions to calculate the average, cheapest and most expensive Total costs respectively.
2 In cell E13, enter an appropriate function to calculate how many services are offered.
3 In cell E14, enter an appropriate function to calculate how many services had a discounted amount of more than $2000.
4 Save the spreadsheet again.

Exercise 5: Searching for information

1 Type the following data in Sheet3 of the DONATIONS spreadsheet.

	A	B	C	D
1				
2		*Job code*	SF	
3		*Service*		
4		*Cost*		
5				

Sheet: MENU

2 Double-click on Sheet3 as MENU.
3 In cell C3, type =VLOOKUP(C2,SERVICE,2,FALSE) and press *Enter*. This compares SF in cell C2 with every cell in the first column of the SERVICES range in the EXPENSES sheet to find SF. Then the data in the second column is selected (Storage facilities) and shown in cell C3. FALSE is added to the function to indicate that the items in the first column (Job code) are not sorted. If they were, you could add TRUE or simply close the bracket as in =VLOOKUP(C2,SERVICE,2).
4 Change the job code in cell C2 from SF to LC. The service is updated in cell C3.
5 In cell C4, type =VLOOKUP(C2,SERVICE,3,FALSE) and press *Enter*. This compares LC in cell C2 with every cell in the first column of the SERVICES range in the Expenses sheet to find LC. Then the data in the third column is selected (Landing charge) and shown in cell C4.
6 Change the job code in C2 from LC to HE. Notice that an error #N/A appears in cells C3 and C4. This is because the code is not found in the SERVICES range of data.
7 Save the spreadsheet again.

Exercise 6: Viewing your functions and formulae

1 Press *Ctrl* and ` (located above the *Tab* key on your keyboard) to display the functions and formulae in the spreadsheet.
2 Adjust the cells to show the functions and formulae clearly.
3 Press *Ctrl* and ` to display your results once again.

Exercise 7: Using the RANK function

Return to the MAIN sheet for this exercise.

1 In cell G3, type 'Priority'.
2 Select the range C5:C10 and name this range as SHIPPING.
3 In cell G4, type =RANK(C4,SHIPPING,1) or in later versions of Excel type =RANK.EQ(C4,SHIPPING,1)
4 Copy the function in cell G4 to cells G5:G10. Which items have the same priority?
5 If the rank function produces an error, then check the format of the dates entered.

Formatting features

You can use a variety of formatting features such as bold, alignment and font size to display your data effectively (Fig 7.35). The options on the Home tab or the Format Cells feature (Fig 7.36) can:

- change the number format
- change the alignment of text or data
- format text and individual characters
- add different kinds of borders
- shade cells with colours or patterns

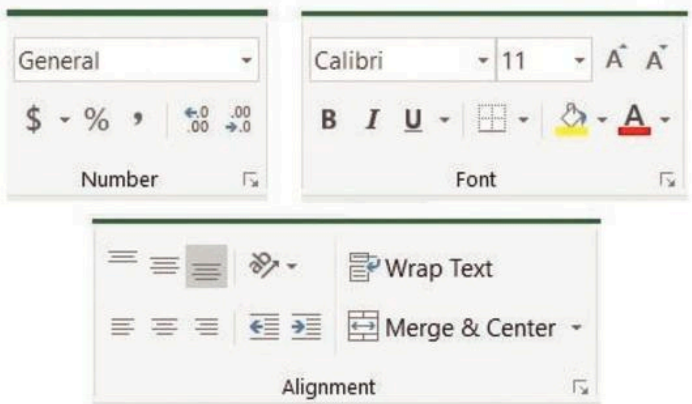


Fig 7.35 Spreadsheets have a variety of formatting features to display your data effectively

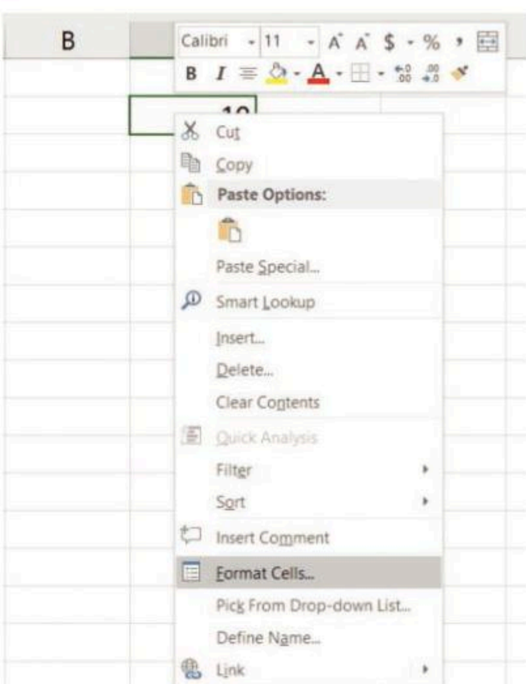


Fig 7.36 Right-click on a cell to reveal the Format Cells feature

In the Format Cells dialogue box, you can make the desired changes in each of the tabbed areas, including formatting numbers, aligning data, customising fonts, applying borders and shading. After making the customisation changes, click OK to close the dialogue box and return to the worksheet.

Format numbers

You can use a variety of formatting features to change a number's appearance. Right-click on a cell containing a number to view the Number tab in the Format Cells dialogue box (Fig 7.37) where you can choose:

- a category of number (currency, percentage, date and so on)
- a style (decimals, commas, and so on).

You can also perform basic number formatting using the icons on the Number section of the Home tab.

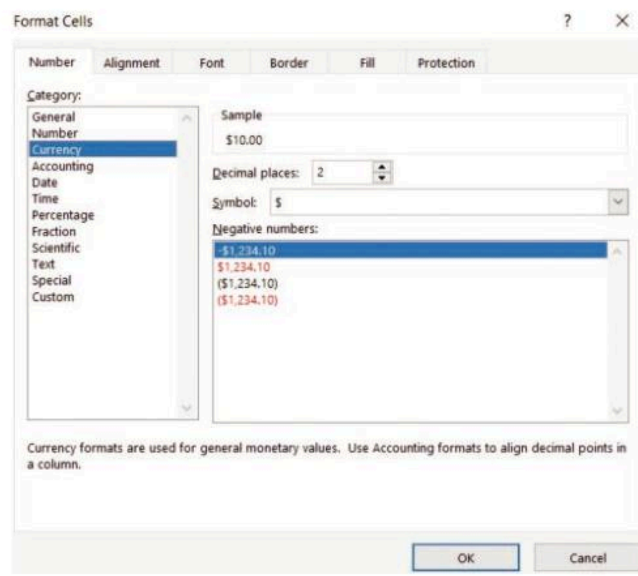


Fig 7.37 You have a choice of formatting features to change a number's appearance

Align data

The Alignment tab (Fig 7.38) has options to change the position of text within a cell. This tab is used to determine:

- the horizontal and vertical alignment of data in selected cells

- the orientation of data in selected cells
- whether long cell entries should be wrapped within the cell (Wrap text)
- whether text size should shrink to fit the column width (Shrink to fit)
- whether selected cells should be merged to form a single cell (Merge cells)
- the direction of the text (left to right).

You can also perform basic data alignment using the icons on the formatting toolbar.

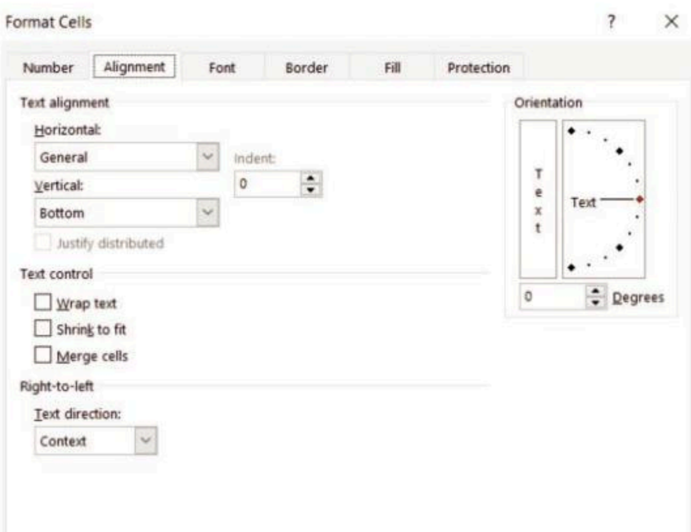


Fig 7.38 The alignment option changes the position of text within a cell

Protection

The Protection tab provides a privacy feature to your worksheet or workbook. By adding a password, unauthorised users are prevented from changing, moving or deleting specific cells of data in a sheet, or from opening or modifying an entire workbook.

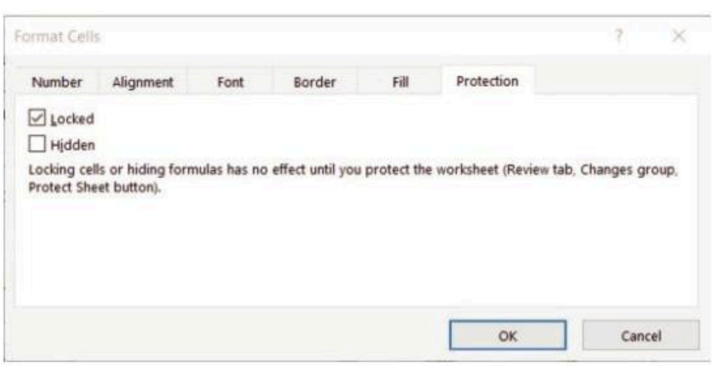


Fig 7.39 The Protection tab provides a privacy feature to your worksheet or workbook

Practical exercises using Microsoft Excel

Exercise 8: Formatting a spreadsheet

1. Open the DONATIONS Excel file which you created in Exercise 1, and select the MAIN sheet.
2. Apply the comma format to numeric data in the sheet. Keep the decimal places to zero.
3. Highlight the headings in row 3 and make them bold.
4. Change the font of the headings in row 3 to Arial 14 point, with a blue colour.
5. Use the Wrap text option on the headings in row 3.
6. Select all the headings in the worksheet (cells A3 to F3).
7. Click the drop-down arrow to the right of the Border icon in the Font section of the Home tab and select the Outside Borders option.
8. Save this spreadsheet file.

Question

1. Identify any three features that are found in each of the following formats:
   a number
   b alignment
   c font.

Sorting

You can rearrange the rows or columns of a list by sorting according to the values in the list. When you sort (Fig 7.40), Microsoft Excel rearranges rows, columns or individual cells by using the sort order that you specify. You can sort lists in ascending (1 to 9; A to Z) or descending (9 to 1; Z to A) order (Table 7.2). The sort can be based on the contents of one or more columns.

Fig 7.40 Data can be sorted in ascending or descending order

Table 7.2 *Examples of sort lists*

Order	Alphabetic	Numeric	Date
Ascending	A, B, C	1, 2, 3	1/1/2019, 1/15/2019, 2/1/2019
Descending	C, B, A	3, 2, 1	2/1/2019, 1/15/2019, 1/1/2019

Sorting a list by one field

1 Click in any cell of the column you want to use to sort the list.

2 Click either the Sort Ascending icon or Sort Descending icon (Fig 7.41). This can be found on the Data tab or menu option, depending on your version of Excel.

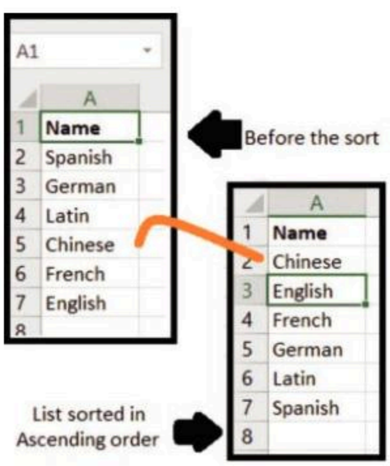


Fig 7.41 Select a cell in the column and click the Sort icon

Sorting a list by more than one field

1 Decide on the the rows or columns that you want to sort.

2 Make sure the cursor is located within the list and click the Sort icon on the Data tab, or right-click and chose Sort, then Custom Sort from the menu. Notice that the range of data will be selected.

3 Select the first field you want to sort by from the drop-down list and specify Ascending or Descending order.

4 Select Add level and repeat step 3 for the second and third fields you want to sort by (if desired).

Filtering records

Filtering is the process of selecting some of the records of a worksheet on the basis of certain criteria. Excel will list only those records that match the selection criteria and hides the others. The full set of data can be viewed at any time. Excel has AutoFilter and Advanced filters. AutoFilter allows selection criteria based only on a single field while Advanced Filtering allows more complex selection criteria.

AutoFilter

Select a table with a header row and for early versions of Excel go to Data option on the Menu bar, click Filter, and select AutoFilter from the sub-menu. In later versions you just need to click the Filter icon on the Data tab of the ribbon. Notice that all the headers now have a drop-down arrow in their cell. Click on one of these arrows to reveal a list of possible filters.

- Clicking on a value will filter for that value.
- Clicking on Show All will display the table in its entirety.
- Clicking on Top Ten activates the Top Ten dialogue box. In the dialogue box, you may choose to filter for Top or Bottom, a number value, and either Items or Percent. For example, you could decide to filter for the Top 12 Items or the Bottom 20 Percent.

- Using the Custom Filter allows you to filter for a range, such as greater than 15 and less than 30 (>15 and<30).

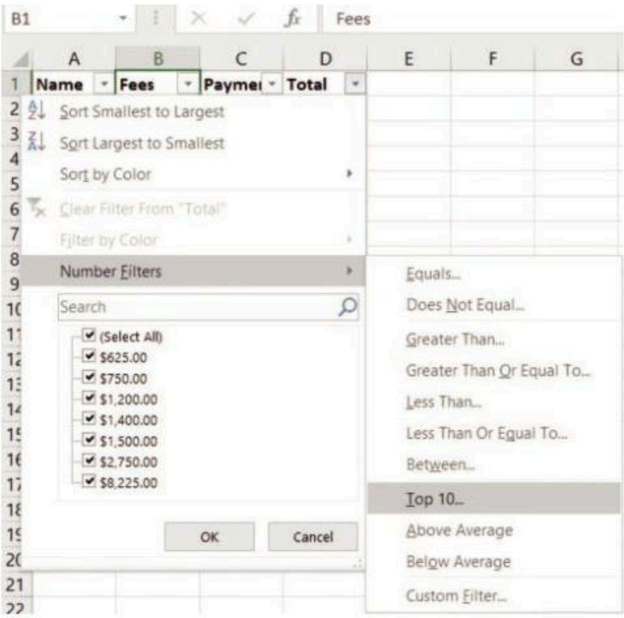


Fig 7.42 Drop-down arrows reveal a list of possible filters

To deactivate the AutoFilter, once again click on the Data option on the Menu bar and select AutoFilter from the sub-menu; click the Filter icon in the Data tab in later versions.

Advanced Filter

Although the AutoFilter makes selecting records very simple, you may wish to have more control over the criteria used. You can place criteria on the spreadsheet itself and use an Advanced Filter to select records. You can then tell the computer the location of the records, the location of the criteria and whether the list should be filtered in-place or copied to another location. We will use the example shown in Figure 7.43 to illustrate Advanced Filter.

Notice the headings in row 1 (Rank, Language, Speakers and Percentage of population) can be copied and pasted in range G1:J1 and range G6:J6. The criteria in G2:J3 consists of<11 and >150. Since these criteria are on the same row, this is an AND criteria. For the record to be selected the Rank has to be less than 11 and Speakers has to be greater than 150. We now click in the data with the original data (the range A1:D21) and then choose the Data, Advanced Filter

Fig 7.43 Option box for the Advanced Filter showing original data, criteria range, and output area

menu options, or Advanced near the Filter icon in later versions.

If you click in the table first, the computer automatically selects the correct range for the table. You can now enter the range for the criteria (G1:J2). Note: if you click on the Copy to Another Location option, you would then also choose a range where the new list should be copied. Figure 7.44 shows the resulting list.

G	H	I	J
Rank	Language	Speakers	Percentage of population
<11		>150	
Rank	Language	Speakers	Percentage of population
1	Mandarin	935	0.141
2	Spanish	390	0.0585
3	English	365	0.0552
4	Hindi	295	0.0446
5	Arabic	280	0.0423
6	Portuguese	205	0.0308
7	Bengali	200	0.0305
8	Russian	160	0.0242

Criteria range

Output Area

Fig 7.44 Result of using the Advanced Filter to find the languages that rank in the top 10 with more than 150 speakers

If we moved one of the criteria to the next line, we create OR criteria. For example, if "<11" is moved from G2 to G3, we create OR criteria. This means a record will show if EITHER criteria is true. When we choose Data > Advanced Filter menu options, however, we must remember to change the criteria range to include the third row to G1:J3 in this example. Figure 7.45 shows the list you get when you do this.

G	H	I	J
Rank	Language	Speakers	Percentage of population
		>150	
<11			
Rank	Language	Speakers	Percentage of population
1	Mandarin	935	0.141
2	Spanish	390	0.0585
3	English	365	0.0552
4	Hindi	295	0.0446
5	Arabic	280	0.0423
6	Portuguese	205	0.0308
7	Bengali	200	0.0305
8	Russian	160	0.0242
9	Japanese	125	0.0192
10	Punjabi	95	0.0144

Criteria range

Output Area

Fig 7.45 Use Advanced filter to find the languages that either rank in the top 10 OR have more than 150 speakers

Pivot tables

As your data increases, it can become more time consuming to update ranges of data, functions and formulae. Depending on how you need to display your results, a **pivot table** makes it easy to summarise your data without altering the original location of your data. Even if more data is added to the spreadsheet, the pivot table can be quickly updated. Pivot charts can also be created from a pivot table.

To create a pivot table from a set of data in a worksheet, you should check that your data is arranged as follows:

- You should have at least three columns of data.
- Each column of data should have its unique field heading.
- Your data should be organised in a tabular format, and not have a blank row between the column headings and the first row of data.
- Check that the data set also does not have blank rows or columns.
- Review the data to ensure that it has been entered accurately. Mixing up data causes incorrect results.

To create a pivot table, click on any cell in your set of data, click the Insert tab and then select the Pivot Table option (Fig 7.46).

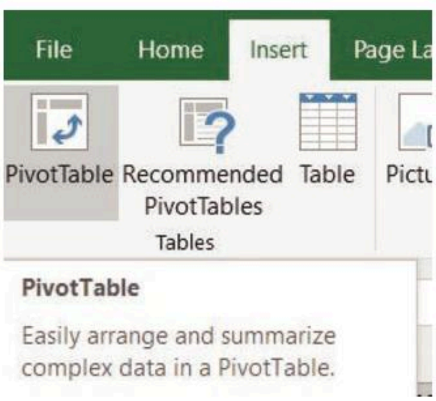


Fig 7.46 Make sure the cursor is in the data before selecting the Pivot Table option on the Insert tab

The dialogue box is displayed with your range of data selected (Fig 7.47). You can choose to place the pivot table on the new sheet or display it on the same sheet. Your pivot table is created by moving fields of data using drag-and-drop options. This creates a view of the original data but in a different format.

One-dimensional pivot table

By default, Excel summarises your data by either summing or counting the items. If so, numeric values

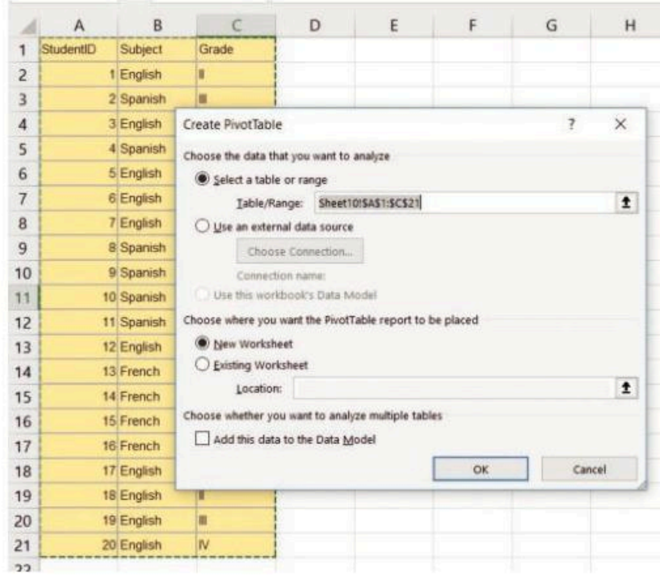


Fig 7.47 The pivot table dialogue box is displayed with your range of data selected

are usually dragged to the Values area. If you also drag a field to either the Rows area or the Columns area, you can create a one-dimensional pivot table.

Suppose you wish to find out how many students in each subject received results. Figure 7.48 shows the Subject field in the Row area while the Grade field is in the Values area. The pivot table shows on the left as you drag the fields to their areas. This new pivot table is located in a new sheet, while the original data remains in its sheet.

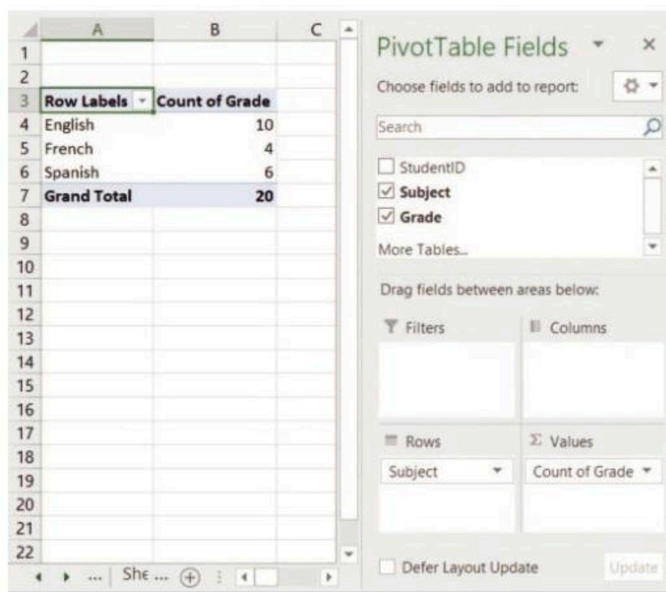
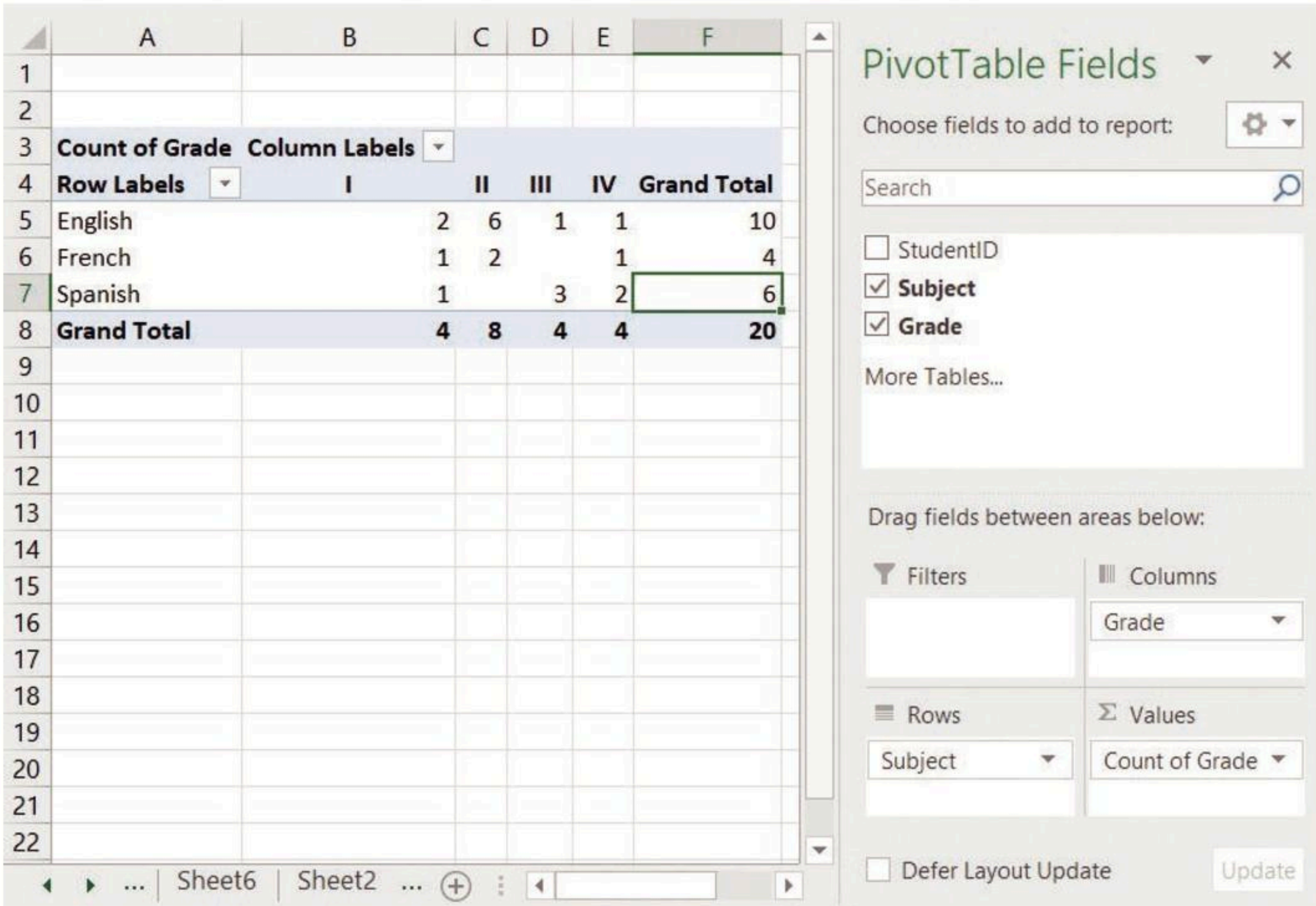


Fig 7.48 Creating a pivot table to show how many students in each subject received results. The pivot table is shown on the left while the fields that formed the pivot table are in the lower right pane

Two-dimensional pivot table

A one-dimensional pivot table shows a column or row of data. If you drag a field to the Rows area and drag another field to the Columns area, then a two-dimensional pivot table is created. Make sure to drag another field to the Values area to complete the pivot table.



Count of Grade	Column Labels				
Row Labels	I	II	III	IV	Grand Total
English	2	6	1	1	10
French	1	2		1	4
Spanish	1		3	2	6
Grand Total	4	8	4	4	20

Fig 7.49 Creating a two-dimensional pivot table to show the number of students who gained grades I to IV in the different subjects. The Subject field is in the Rows area, the grade field is in the Columns area, while the grade field is also dragged to the Values area

Frequency distribution

Sometimes you may want to count the number of times a value occurs in a set of data or how many times a specific payment was made between two dates. Creating a frequency distribution provides this information quickly for you. For example, suppose you have a list of students with their ages, and you wish to find out how many students grouped in two-year intervals registered for exams. Figure 7.50 shows the initial pivot table that is created after you drag the age field to both the Rows area and the Values area. Grouping the ages in intervals of 2 produces the frequency distribution for those in the two age ranges who registered for the subjects.

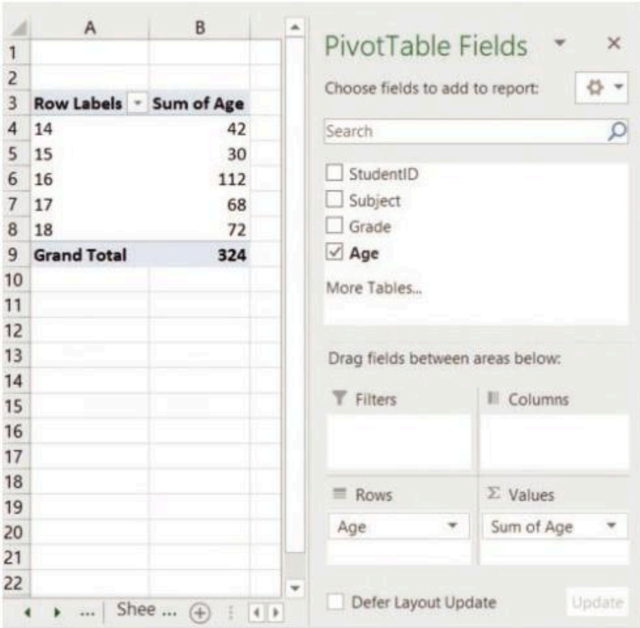


Fig 7.50 shows the initial pivot table created by dragging the age field to both the Rows area and the Values area

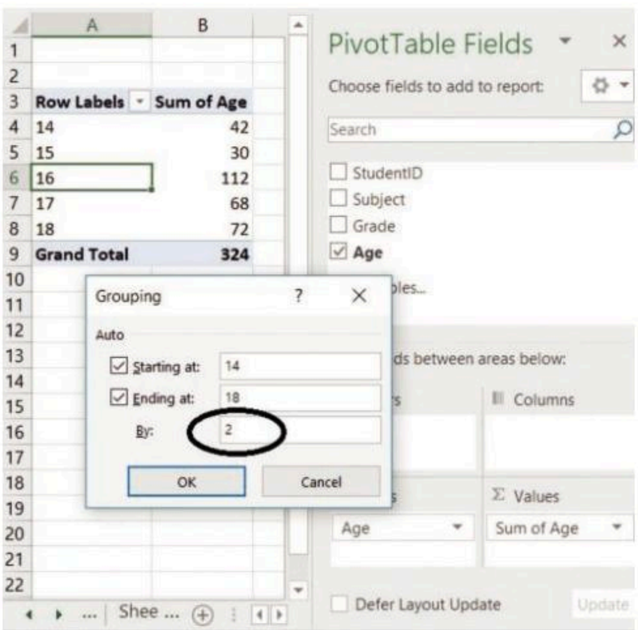


Fig 7.51 Right-click in the Row labels and select Group to enter the interval for the age ranges

	A	B
1		
2		
3	**Row Labels**	**Count of Age**
4	14-15	5
5	16-18	15
6	**Grand Total**	**20**

Fig 7.52 The frequency distribution showing the number of students in the two age ranges who registered for the subjects

Pivot charts

Now that you can summarise your data into a pivot table, a pivot chart can help you to visualise your results. To create a pivot chart, first select any cell within your pivot table. Then in the Pivot Table Tools section, locate the Analyse option and select Pivot Chart. You can now select a suitable chart type and click OK. Your new pivot chart will be placed on the same sheet as the pivot table.

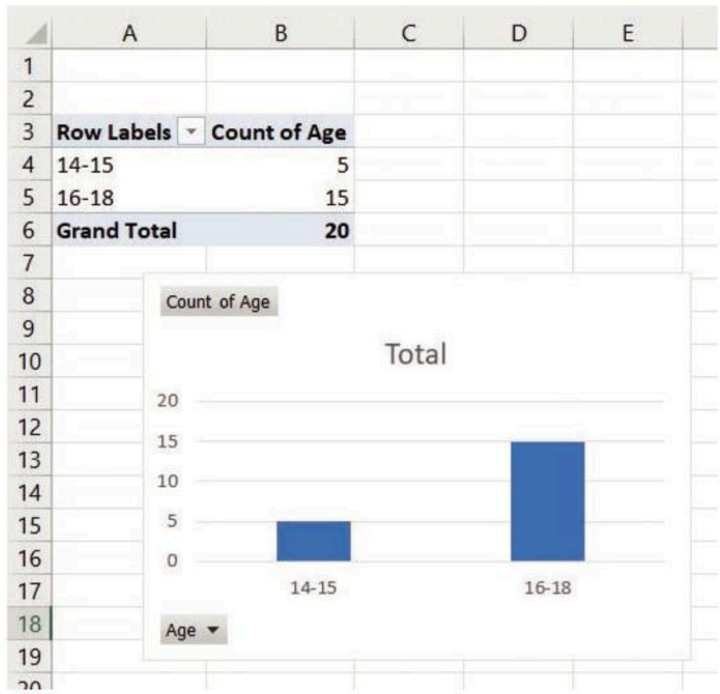


Fig 7.53 Pivot chart created from the frequency distribution

Modifying pivot tables

As you add or delete columns or rows in the original set of data, these changes are not automatically updated by the pivot table. To update a pivot table, right-click anywhere in the pivot table and select Refresh.

Sometimes you may not want to view all the results in your pivot table. Filtering data can be done by clicking on the arrow next to the row or column labels. This shows the list of options to select those you will to include or leave out. In Figure 7.54, we want to view only grades I to III.

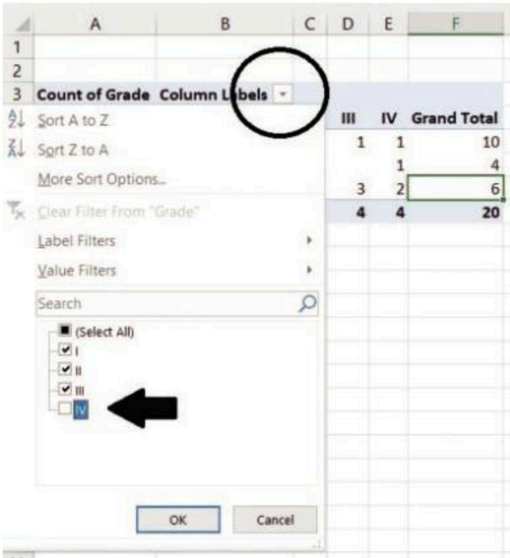


Fig 7.54 Removing the check mark for the grade IV option so that it will not be shown in the pivot table

Pivot tables summarise your data by either summing or counting the items. You can, however, change the type of calculation such as average, maximum, or minimum. Right-click on the cell with the aggregate function (Sum of Age in this example), then select Value Field Settings (Fig 7.55) and select the new aggregate function (COUNT in this example) and click OK (Fig 7.56).

To delete a pivot table, select the entire range of data that makes up the pivot table, then press *Delete*. It will not alter the original data or other pivot tables or charts. You may want to delete the sheet with the pivot table if that is easier.

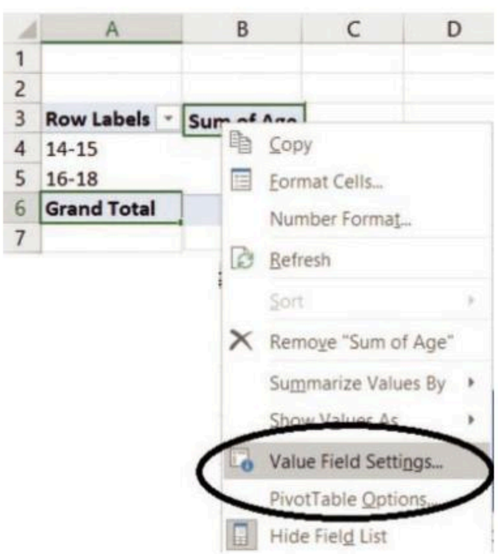


Fig 7.55 Right-click on the Sum of Age cell, then select Value Field Settings

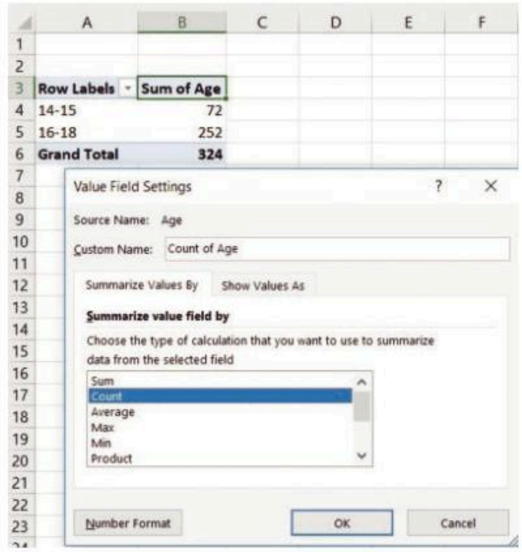


Fig 7.56 Select the COUNT aggregate function to replace the SUM function and click OK

Questions

1 State the most suitable term that describes the following descriptions:
  - **a** rearranges a list of data in order
  - **b** selects specified records that meet certain criteria
  - **c** extracts data that meets one or more criteria and copies it to another location on the sheet
  - **d** summarises data in another sheet without altering the original location.

2 You have the following information on where you ate lunch and how much you spent:

Day	Amount	Location
Monday	$15.00	Lunchroom
Tuesday	$25.00	Desk
Wednesday	$10.00	Café
Thursday	$13.00	Lunchroom
Friday	$14.00	Desk

  - **a** Write the result from the above table if the data was sorted:
    - **i** by Amount in ascending order
    - **ii** by Day in ascending order
    - **iii** by Location first in ascending order and then by Amount in descending order.

3 Write the result from the above table if the data was filtered by the following criteria:
  - **i** Amount <15
  - **ii** Location = "Desk" or Amount <15

Practical exercises using Microsoft Excel

Exercise 9: Using Sort, Filter and Pivot Table

1 Enter the following data into a worksheet starting at cell A1. Save the workbook as RESULTS.

Sheet: RESULTS

Student ID	Subject	Grade	Age
1	English	II	14
2	Spanish	III	15
5	French	I	18
6	French	II	18
10	Spanish	IV	16
11	Spanish	III	16
12	English	II	16

2 Select the range of data and name it LANG.
3 Sort the data by Grade in ascending order.
4 Sort the data by Subject in ascending order, and also by Grade in descending order.
5 Use the AutoFilter feature to view:
- **a** information for the 18-year-old students
- **b** all subjects with Grade IV
- **c** students who are under 18 years old with Grade II in a subject
- **d** all subjects ending in 'ish'.

6 Create an Advanced Filter, to select:
- **a** all students who obtained grades I to II
- **b** all students with Grade I OR students older than 17.

7 Use the Pivot Table feature to:
- **a** count the number of students who have results for each subject
- **b** count the number of students in each age group
- **c** create a table with Grades in the rows and the Subject in the columns. Then show how many students obtained each grade for the different subjects.

Exercise 10: Sorting, filtering and frequency distribution

1 Enter the following data into a worksheet starting at cell A1. Save the workbook as LANGUAGES.

Sheet: LANGUAGES

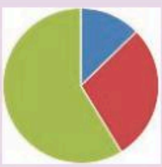
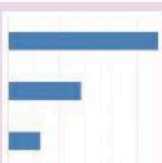
Rank	Language	Speakers	Percentage of population
1	Mandarin	935	0.141
2	Spanish	390	0.0585
3	English	365	0.0552
4	Hindi	295	0.0446
5	Arabic	280	0.0423
6	Portuguese	205	0.0308
7	Bengali	200	0.0305
8	Russian	160	0.0242
9	Japanese	125	0.0192
10	Punjabi	95	0.0144
11	German	92	0.0139

2 Sort the data by Language in ascending order.
3 Sort the data by Percentage of population in descending order.
4 Use the Advanced Filter to find the languages that rank in the top 10 with more than 150 speakers.
5 Use an Advanced Filter to find the languages that either rank in the top 10 OR have more than 150 speakers.
6 Create a frequency distribution of the speakers. Show in intervals of 150.

Graphing (charting) data is a very useful way to show patterns, comparisons and trends in data. Instead of having rows and columns of data, a graph can make a strong visual impact. This often makes the data much easier to understand.

You can create a number of chart types with Excel. The major chart types and their purposes are shown in Table 7.3.

Table 7.3 *Types of charts*

	Pie	Shows the relationship among parts of a whole
	Bar	Compares values at a given point
	Column	Similar to bar charts; used to show the difference between items
	Line	Shows trends and change of values over time
	Scatter	Similar to line chart; shows the difference between two sets of values
	Area	Similar to line chart; shows the amount of change over time

Charts may be two- or three-dimensional; a 2D chart displays a horizontal (x) axis and a vertical (y) axis, while a 3D chart displays three axes (x, y and z).

A chart is linked to the worksheet data that it is created from, and it is updated automatically when the worksheet data changes.

A chart is a pictorial or visual representation of data contained in the Excel worksheet. The idea of plotting information in a chart is to be able to analyse data more quickly without having to interpret a set of data. A chart can be embedded in the worksheet (Fig 7.57) or a separate chart sheet. When this is done, the chart is an individual worksheet, but the chart sheet has no cells, and no data or formulae may be entered into the chart sheet. If a chart is set up as a chart sheet, it must be printed on a page by itself. The chart may be printed alone or with the worksheet data.

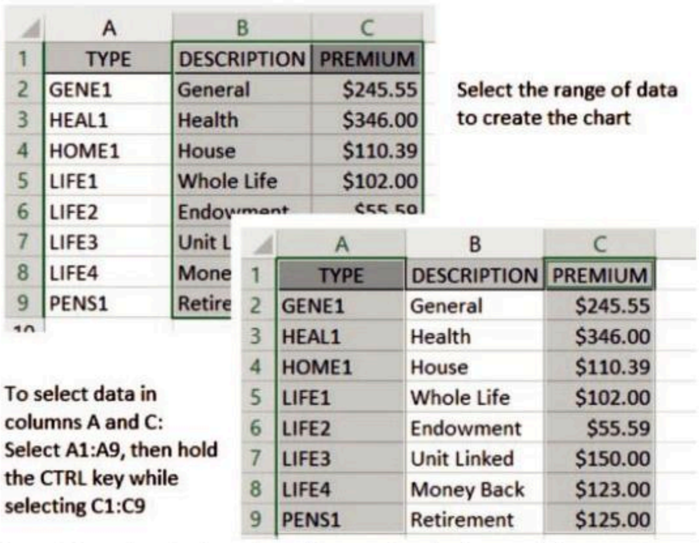
B	C	D	E	F	G	H
DESCRIPTION	PREMIUM					
General	$245.55					
Health	$346.00					
House	$110.39					
Whole Life	$102.00					
Endowment	$55.59					
Unit Linked	$150.00					
Money Back	$123.00					
Retirement	$125.00					

Fig 7.57 Charts can be embedded in the worksheet

Creating a chart

Since the chart is used to illustrate specific data in the worksheet, it is important to determine what type of chart will be best suited to present the data. The other consideration is what data will be put on the chart. Excel can create numerous chart types, the most common being column, bar and pie (Table 7.3).

The simplest way to create a chart is to first select the data that will be used on the chart. Data for the chart will normally begin with column headings followed by the numeric data. Chart data is selected in ranges but not necessarily adjacent ranges. For example, a chart can be created by selecting the range B2:C9 (Fig 7.58,



	A	B	C
1	TYPE	DESCRIPTION	PREMIUM
2	GENE1	General	$245.55
3	HEAL1	Health	$346.00
4	HOME1	House	$110.39
5	LIFE1	Whole Life	$102.00
6	LIFE2	Endowment	$55.59
7	LIFE3	Unit Linked	$150.00
8	LIFE4	Money Back	$123.00
9	PENS1	Retirement	$125.00

Fig 7.58 First select the data that will be used on the chart, whether in columns next to each other (top) or not (bottom)

top). However, to create another chart, of the premiums by Type, select the range A1:A9, then press and hold the *Ctrl* key while selecting C1:C9 (Fig 7.58, bottom). Titles and subtitles should not be selected: enter them on the chart after it is set up. Next, locate the Chart Wizard icon on the Standard toolbar or the Insert tab or the Recommended Charts icon on there and follow the series of dialogue boxes to create the chart. As the chart is being created, you may see a sample preview and modify your chart if necessary.

After completing the chart using the wizard, you will probably need to resize an embedded chart and move it to prevent it covering the worksheet data. When the chart is in the desired location, decide if it shows the data correctly. Make sure there is enough information on the chart for it to be meaningful for the end user. For example, not all charts need a legend. If there is only one set of data being plotted and the data is defined by an axis title, the legend is unnecessary. Also look at and change formatting for consistency and readability, if needed. Figure 7.59 explains the different parts of a chart.

1 The area comprising the chart
2 The plot area
3 The data points that are plotted to form the chart
4 An optional label for a data point
5 The vertical axis that plots the values
6 The horizontal axis that plots the categories
7 Vertical axis title
8 Horizonal axis title
9 Main chart title
10 Vertical axis gridlines
11 Horizonal axis gridlines
12 Legend

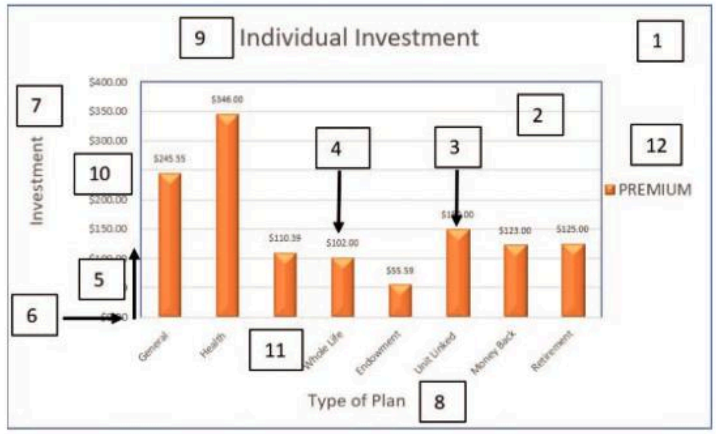


Fig 7.59 Parts of a chart

Modifying a chart

A chart is like other worksheet data: you can move it, change its size, delete it and place borders around it.

Moving charts

It is possible to move the chart to a new location within the worksheet. You move a chart by selecting it and then dragging it to its new location in the same worksheet.

1 Click in the background (white space) of the chart. Notice the chart now has eight 'handles'. Make sure that you select the whole chart, not just one of its components such as the title or legend.
2 Click the left mouse button and drag the chart to its new location in the same worksheet.

Sizing charts

The chart may be resized so that it displays data better.

1 Click on the background of the chart. Notice the eight 'handles' on the chart.
2 Place the tip of the mouse pointer on one of the handles.

3 When the pointer changes to a double-sided arrow, click and drag the mouse to resize the chart.
- Using one of the corner handles resizes the chart proportionately.
- Using one of the left, right, top or bottom sides resizes the chart vertically (taller) or horizontally (wider).

Deleting charts

Select the chart and press the *Delete* key or the *Backspace* key to delete it.

Changing charted data

Charts are linked to the selected data. Whenever the data changes, the chart automatically adjusts to reflect those changes. Using the mouse, right-click on the chart to see menu options for modifying the chart. Some of the types of changes that may be available are:

- Chart Type: modify the chart type
- Source Data: change the location of data that is used to create the chart
- Chart Options: modify the same options that you had when you created the chart (add or remove data labels, legend, titles and so on).
- Chart Location: place the chart on a different worksheet
- Add Data: add data to a chart by setting a new range
- Add Trendline: show the 'best-fit line' for a series of data
- 3D View: modify orientation of a 3D chart type.

Questions

1 Give one reason why a chart can be more useful than analysing data in a sheet.

2 Explain the difference between an embedded chart and a chart sheet.

3 Define the following chart objects: chart title, category axis, value axis, data series.

4 Explain the difference between a column (or bar) chart and a pie chart.

5 Explain whether a legend is necessary for the chart in Figure 7.57.

Practical exercises using Microsoft Excel

Exercise 11: Creating a chart

1 Enter the data shown in Figure 7.58. Select the range B1:C9.

2 Locate the Chart Wizard on the Insert tab.

3 View the Chart Types and choose the Column chart.

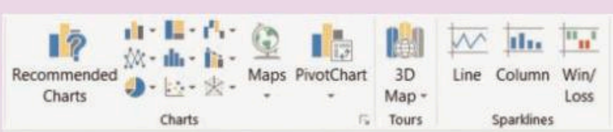


Fig 7.60 Selecting the chart type

4 Once your chart has been created, you can modify the design of the chart, including various layout options and changing the text and colour of the chart. Choose the layout that will add title axes to the chart. Edit the horizonal axis to Type of Plan and the vertical axis to Investment. Give the Chart the title 'Individual Investments'.

Exercise 12: Moving the chart to a new sheet.

1 Right-click in the corner of your chart and select Move Chart (Fig 7.61).

2 Select New Sheet and Click OK (Fig 7.62).

3 The chart will be moved to a new sheet named Chart1.

Fig 7.61 Selecting the option to move the chart to a new sheet

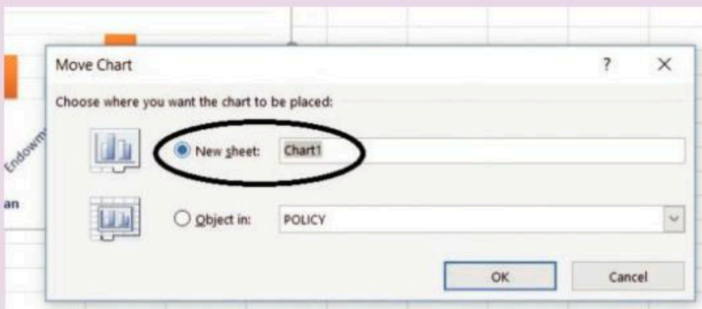


Fig 7.62 Completing the process of moving the chart to a new sheet

Exercise 13: Monitoring lunch spending

After spending money for lunch over a week, you wish to use a chart to track you trend of spending. Using the set of data below, create a line chart to show this trend. Remember that formatting data is useful, even when creating charts.

1 Type the following data in a spreadsheet, and save the sheet as Monitoring Spending.

Amount spent on lunch	
Day	**Amount**
Monday	15.00
Tuesday	5.00
Wednesday	10.00
Thursday	13.00
Friday	14.00

2 Format the values for currency with no decimal places.
3 Create a line chart to show the total payments for each language.
4 Format the chart to include axes titles.
5 Name the horizontal axis as 'Day'.
6 Name the vertical axis as 'Amount'.
7 Name the main title as 'Amount spent on lunch'.
8 Move the chart to a new sheet.
9 Change the type of chart to a pie chart.
10 Explain which type of chart is more appropriate for this type of data.
11 Save the spreadsheet again.

Exercise 14: Fees to learn a language

Create a chart using the set of data below. The chart should compare the fees charged for teaching various foreign languages.

1 Type the following data in a spreadsheet starting at cell A1, and save it as Language Classes.

	A	B	C
1	**Language**	**Fees**	**Payments**
2	Chinese	$250.00	6
3	English	$125.00	5
4	French	$175.00	8
5	German	$275.00	10
6	Latin	$150.00	5
7	Spanish	$200.00	6

2 Create a bar or column chart to show the fees for each language class.
3 Format the chart to include axis titles.
4 Name the horizontal axis as 'Language'.
5 Name the vertical axis as 'Dollar Amount'.
6 Name the main title as 'Fees for Each Language Class'.
7 Move the chart to a new sheet.
8 Save the spreadsheet again.

Exercise 15: Comparing the number of payments for language classes

This exercise expands on Exercise 14 to compare the number of payments needed for each language class.

1 Use the same data as in Exercise 14.
2 Create a bar or column chart to show the number of payments for each language class. Remember: to select non-contiguous data, select the first column of text data then hold the *Ctrl* key while selecting the next column of data.
3 Format the chart to include axis titles.
4 Name the horizontal axis as ‘Language’.
5 Name the vertical axis as ‘Number of Payments’.
6 Name the main title as ‘Comparison of Payments for Language Classes’.
7 Move the chart to a new sheet.
8 Save the spreadsheet again.

Exercise 16: Determining the total cost for each language class

This exercise expands on Exercise 14 to determine the total cost of each language class.

1 Type the heading ‘Total’ in cell D1.
2 Use a formula in cell D2 to calculate the total cost for Chinese classes. You should have a total payment of $1500.00 for Chinese.
3 Copy the formula from cell D2 to the remaining rows for each language.
4 Create a bar or column chart to show the total payments for each language class. Remember: to select non-contiguous data, select the first column of text data then hold the *Ctrl* key while selecting the next column of data.
5 Format the chart to include axis titles.
6 Name the horizontal axis as ‘Language’.
7 Name the vertical axis as ‘Total Cost’.
8 Name the main title as ‘Total Cost for Each Language Class’.
9 Move the chart to a new sheet.
10 Save the spreadsheet again.

Microsoft Excel provides a number of optional settings to change the appearance of a printed page. You can change margins, adjust orientation, add headers/footers and modify other features (Fig 7.63). Before a document is printed, you should always ensure that the page is set up correctly by previewing the print job.

1 Go to the File tab or menu.
2 Select Print. Depending on your version of Excel there may be different ways to view the setup of your page.
3 Customise the print features that affect the overall sheet with the Sheet tab on Page Setup (Fig 7.63).
4 Print area: Specify the block to be printed. If a block of cells is selected before you select this option, the print area will already be displayed.
5 Print titles: Specify rows to be printed along the top or the columns to be printed along the left of each page.
6 Print: With options for:
   - Gridlines – suppress or print the sheet gridlines
   - Black and white – convert colour images to black and white for faster printing
   - Draft quality – speed up the printout by printing fewer graphics and suppress the gridlines
   - Row and column headings – print the row numbers and column letters around the border of the printout
   - Comments – include cell notes
   - Cell errors – specify the content printed in cells containing errors
   - Page order – specify the order in which the pages will print.

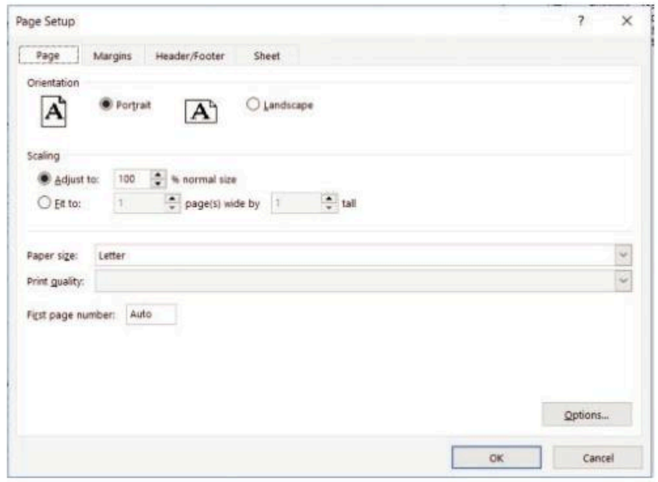


Fig 7.63 The Page tab options on the Page Setup dialogue box is one place you can adjust the appearance of a printed page

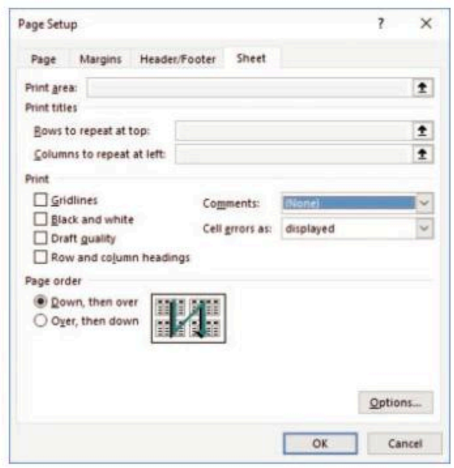


Fig 7.64 The Sheet tab gives further options in the Page Setup dialogue box

Question

1 Explain one advantage and one disadvantage for printing your data or chart.

Practical exercises using Microsoft Excel

Exercise 17: Printing data and charts

1 Open the Monitoring Spending worksheet or type the data in the table in Exercise 13.
2 Print the data in the spreadsheet. If you do not have a printer, try printing the data to a PDF file.
3 Select and print the chart.
4 Open the Language classes worksheet or type the data in the table in Exercise 14.
5 Print the data in the spreadsheet. If you do not have a printer, try printing the data to a PDF file.
6 Select and print the chart.

Importing files into Excel

You can import files from an outside source into Excel, providing you have a way of distinguishing one column of data from another. When you select the File, Open menu option, you can change the Files of type to a Text file or other required file type.

When you choose the file you want, Excel will take you through the Text Import Wizard.

Step 1 of the wizard (Fig 7.65) will let you decide if the file is delimited or fixed width. If it is delimited, there would be a character (such as a space, comma or tab) separating one column from the next. If it is fixed width, spaces were used to line up the columns.

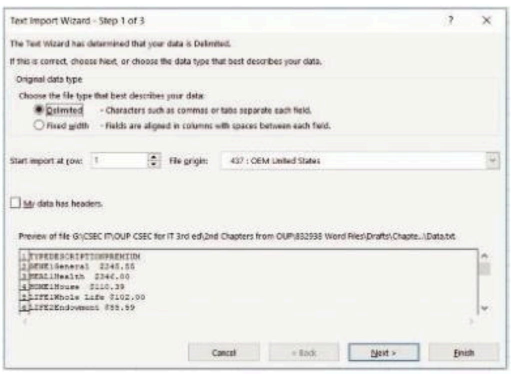


Fig 7.65 Formatting the text to be imported

Figure 7.66 shows what step 2 of the wizard would look like if you had chosen delimited. You would then choose the character that indicates a separation between one column and another. If you wish, you can treat consecutive delimiters as one. If your data were fixed width, you would click in the data area at the exact spot(s) where you want the column splits to be.

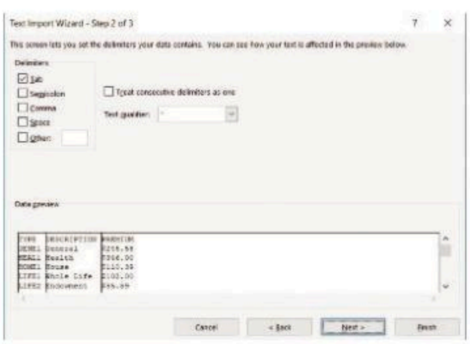


Fig 7.66 Determining the columns of data

In step 3 of the wizard (Fig 7.67), you can format the data in each column if you want. You can even choose not to import a particular column.

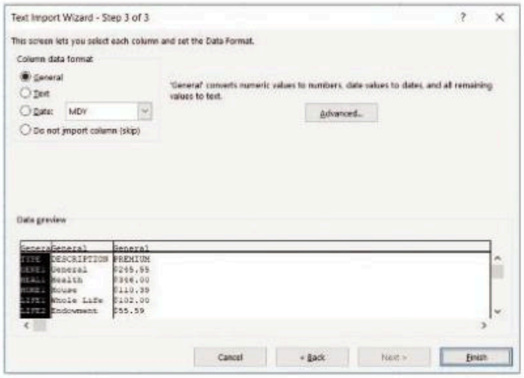


Fig 7.67 Formatting each column of data

Linking files in Excel

Sometimes the data you want is in another file. Linking a cell to a cell in another worksheet is a very simple process. In the cell where the link will go, type an equals sign, then click on the cell in the worksheet and press *Enter*. Excel links the two cells. It is best to have both files open to make the link simple. Using Switch Windows in the View tab or the Window menu in earlier versions, switches from one workbook to the other.

Figure 7.68 shows part of the worksheet where your result will be displayed. The name of the sheet, then an exclamation mark (!), separates the sheet name from the cell. Figure 7.69 shows the final result.

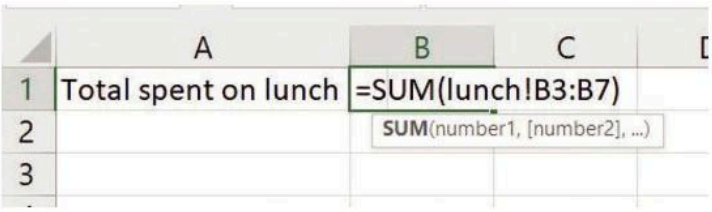


Fig 7.68 The sheet where your result will be shown

Fig 7.69 The value is now linked from one worksheet to another

Question

1 The following function was used in a cell:
=MAX(PRICES!A4:A12)

- **a** State the name of the function.
- **b** State the name of the sheet that linked the cells.
- **c** State the range of cells.
- **d** What is the purpose of the exclamation mark (!)?

Practical exercises using Microsoft Excel

Exercise 18: Importing data

1 Locate and open Notepad or WordPad.
2 Type the following data. Use tabs to separate the three columns.

Name	Type	Age
Brown	Mixed	12
Sheba	Alsatian	14
Duchess	Great Dane	10

3 Save the file as Dogs.txt.
4 In a new spreadsheet, open the file Import. Remember to select the Files of type option as Text files.
5 Click Next.
6 Ensure that the Tab delimiter is selected.
7 Click Next and then Finish.
8 Your table should be imported in a sheet labelled Dogs.

Exercise 19: Linking cells

Open the Monitoring Spending worksheet and edit the cells as shown or enter the data below starting at cell A1:

	A	B
1	**Name:**	Annissa
2	**Day**	**Amount**
3	Monday	15.00
4	Tuesday	5.00
5	Wednesday	10.00
6	Thursday	13.00
7	Friday	14.00

Sheet1

1 Double-click on Sheet1 at the bottom of the sheet. Sheet1 becomes highlighted. Type the name 'Week 1' and press *Enter*.
2 Go to Sheet2 of the spreadsheet and name it 'Summary'.
3 In cell A1, type '='
4 Click on the Week 1 sheet, click on cell B1 and press *Enter*.
5 You have linked the cells containing Annissa.
6 In cell A2 of the Summary sheet, type 'Average spending'.
7 In cell A3 of the Summary sheet, type 'Total spending'.
8 In cell B2, type '=AVERAGE('
9 Click on the Week 1 sheet.
10 Select the range B3:B7, then type')' and press *Enter*. You should see the average amount spent.
11 Click on the Week 1 sheet.
12 Select B3:B7 and name the range as Money.
13 Click on the Summary sheet and in cell B3, type '=SUM(Money)' and press *Enter*.
14 Click on the Week 1 sheet and change Annissa to your name.
15 Click on the Summary sheet and you will see that the cell has been updated with your name.
16 Click on the Week 1 sheet and change the money for one of the days.
17 Click on the Summary sheet to see the updated averages and total spent.

Multiple choice questions

1 Spreadsheets are most useful for working with:
- **a** videos
- **b** payroll
- **c** networks
- **d** brochures.

2 A spreadsheet is a grid of:
- **a** cells
- **b** rows
- **c** columns
- **d** addresses.

3 Spreadsheets allow you to perform __________ calculations.
- **a** 'how to'
- **b** 'what if'
- **c** 'when is'
- **d** 'why not'.

4 Which of the following functions involves calculating loan payments?
- **a** COUNTA
- **b** PMT
- **c** RANK
- **d** VLOOKUP.

5 Consider the following terms:
- **i** relative addressing
- **ii** absolute addressing
- **iii** naming a range of data.

Which of the terms perform the same tasks?
- **a** **i** and **ii**
- **b** **i** and **iii**
- **c** **ii** and **iii**
- **d** **i**, **ii** and **iii**.

6 A pivot table that uses the same field in the row and values area is called a:
- **a** pivot chart
- **b** frequency distribution
- **c** one-dimensional table
- **d** two-dimensional table.

7 Which of the following charts shows the data horizontally?
- **a** bar
- **b** column
- **c** line
- **d** pie.

8 When you insert a copy of Excel data into a Word document, the data is __________ in the Word document.
- **a** moved
- **b** pasted
- **c** typed
- **d** written.

9 Each of the following functions automatically produces the outcome 'True' or 'False' as a result, *except*:
- **a** AND
- **b** IF
- **c** NOT
- **d** OR.

10 The purpose of the VLOOKUP function is to __________ related records.
- **a** delete
- **b** find
- **c** replace
- **d** summarise.

Short answer questions

11 Keith is traveling to conduct workshops across the region and needs to keep track of his departure and arrival dates.

	A	B	C	D	E	F	G	H	I
1	***TR_ID***	***Country***	***Arrival***	***Departure***	***Days***	***Claim***	***Day off?***		
2	6985	Guyana	05/09/2019	05/12/2019					
3	6987	Trinidad	05/16/2019	05/20/2019					
4	7295	Jamaica	05/25/2019	05/31/2019					
5	7324	Barbados	06/15/2019	06/28/2019					
6	7361	Antigua	07/13/2019	07/16/2019					
7	7455	Belize	07/21/2019	07/29/2019					
8									
9								*150.00*	

Fig 7.70

a Cell H9 has been named as AMT. Explain the purpose of naming a range of data.

b Write formulae or functions to calculate answers to each of the following questions:

- **i** How many countries did Keith visit?
- **ii** How many days did he spend in Antigua?
- **iii** How many days did he spend travelling in total?
- **iv** What is the longest time that he spent overseas?
- **v** Keith claims $150 for each day he has spent overseas. Using AMT, determine how much money he has claimed for Antigua.
- **vi** In cell G2, output 'Yes' if he has spent more than five days in a country, otherwise leave the cell blank.
- **vii** Total the number of times that 'Yes' could be shown in column G.

c State the results of **b i** and **b ii** that would be seen in the spreadsheet.

d State the most appropriate formatting for each of the following columns of data:

- **i** Column E
- **ii** Column F.

e The spreadsheet needs to be updated:

- **i** The date in D5 should have been 06/18/2019 instead of 06/18/2018. Explain what type of error has occurred and what checks could have been used to prevent it.
- **ii** He needs to insert a row of data at row 5. Explain what happens to the data currently in row 5.

f Keith wants to access the spreadsheet when he travels so that he can update it. The file is stored on a memory stick.

- **i** Describe one advantage and one disadvantage of using a memory stick.
- **ii** Suggest an alternative option for storing his file, and give one disadvantage of this option.

g As a practical exercise, open a blank spreadsheet, enter the data shown for this question and use the functions and formulae in tasks **a** to **d** as a guide to complete the spreadsheet.

12 Norla is preparing to submit travel information that she entered in the spreadsheet shown below.

	A	B	C	D	E	F	G
1	**TRAVEL for July to Sept 2019**						
2							
3	***Country***	***Arrival***	***Departure***	***Days***	***Claim***		***150.00***
4	Guyana	07/09/2019	07/12/2019	3	450		
5	Trinidad	07/18/2019	07/21/2019	3	450		
6	Jamaica	07/29/2019	07/31/2019	2	300		
7	Barbados	08/17/2019	08/19/2019	2	300		
8	Antigua	08/23/2019	08/26/2019	3	450		

Fig 7.71

a State:

i the feature that has been applied to row 1

ii the type of date format that has been applied to the Arrival and Departure columns.

b Write a function or formula to produce the average number of days she spends travelling.

c Norla uses an advanced filter to extract the names of countries where she spent two days.

i State the criterion/criteria and which column it/they apply to.

ii List the countries that would be output from the advanced filter.

d Norla realises that her spreadsheet file is corrupted.

i Explain what procedure she should follow so that she does not lose data in the future.

ii Describe two options that she could try to recover her data.

iii Describe one computer-related professional who could help to retrieve her data.

CHAPTER 8

DATABASES

8.1 Introduction to database management

Manual and computerised databases

Fig 8.1 Data can be collected on index cards and stored in filing cabinets. In this example of a school database there are three 'tables' (files) of students, teachers and grades

Nowadays, computerised databases are in widespread use, as they help people to quickly find the information that they want. They also vary in size and use depending on what is required. Small databases, such as those that keep information about a music collection, can be run on a personal computer at home. Larger databases now play an important role in how our society works. Industrial, commercial and public organisations use databases to maintain their businesses and services.

Other computerised databases include flight information systems and database systems in public libraries.

Examples of how we use these large databases include:

- booking holidays and airline tickets
- using an online store to search a range of millions of products for a particular item
- accessing a police computer database, with requests from police officers who want information about criminal suspects or stolen items.

Although spreadsheets and databases have similar features, there are three main differences:

- Databases are more often used for applications with a large amount of text, whereas spreadsheets can handle complex numerical calculations more easily.
- Very large applications with thousands of entries are more often handled in databases.
- The way they work in the background is different. When you work in a spreadsheet, you view the data you are entering. In a database, you see only the data you are entering at the time – you have to request a report or different display to see more of the information.

A **database management system (DBMS)** is the term for any program that handles the storage, modification and retrieval of data, as well as controlling who has access to the information. Database programs, such as Microsoft Access, Lotus Approach, FileMaker Pro and Corel Paradox, are available on personal computers and allow people to create their own databases at home, school or work.

Table 8.1 *Advantages and disadvantages of a computerised database*

Advantages	Disadvantages
• Can save enormous amounts of paper as well as filing space • Data can easily be entered by keyboard or scanners • Speed – data can be found, calculated and sorted very quickly • Data can easily be changed and updated • Data needs to be entered only once, yet can be presented in many different ways. A whole range of different queries and reports can be produced • Data can be checked on entry • Passwords can be set to allow access only to those with permission to use the database • The data structure of a database can be changed, with new fields added, even after the database has been created. A paper-based system would have to be restarted from scratch • Data can be imported and exported to other programs • A database file can be automatically linked to others • Databases can be shared with other users if the computer is part of a local or wide area network. This includes the Internet	• The computer(s) and peripherals required can be very expensive • If the computer, or computer network, is not working, then the database cannot be used • Security is very important as some people may attempt to get access to confidential information, sometimes by illegally hacking into the program or data • The database file can become corrupted or infected by a computer virus. This can lead to the file not working properly. In some cases, the database may not work at all. Making a backup copy of the database is therefore essential • There is often a limit to the size of a database file • Some databases can be complicated to use • Some databases require much time to be spent on staff training, which can be costly • Data may be stored incorrectly

Questions

1 Give an example of a 'paper database'.

2 Give two examples of large databases that might be used to help members of the public.

3 Annissa is opening a small cake business. Explain whether a word processor, database or a spreadsheet would be suitable for each of the following scenarios:

- **a** She first needs to store the names and contact information of her customers, types of cakes ordered and the occasion.
- **b** She then wants to store the amount of money she receives weekly from cake sales so that every three months she can analyse her profits using a graphic.
- **c** Annissa wants to keep track of the quantities of items used to ensure she has sufficient ingredients available in storage.

Let us first examine what makes up a database.

- The main purpose of a **database** is to store data. It stores this data in a number of related files, more commonly called tables.
- A table consists of a collection of **records**.
- A **record** consists of a number of **fields**.
- A **field** is the smallest piece of data that can be stored.

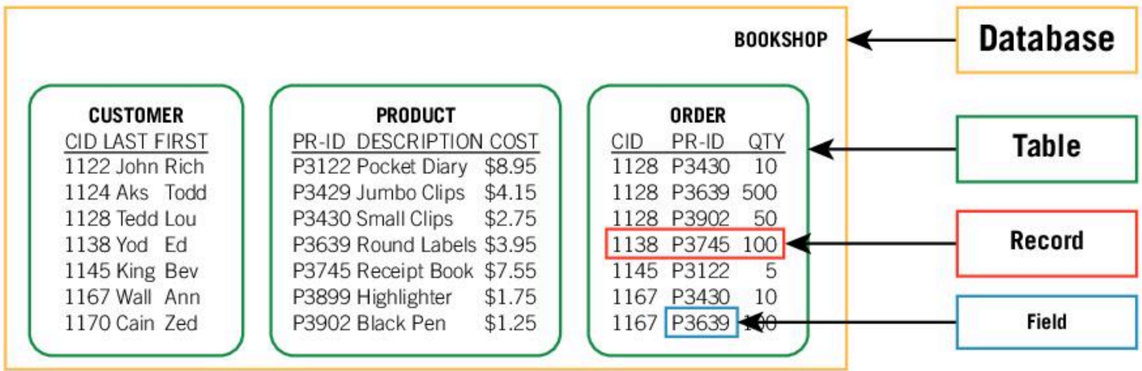


Fig 8.2 Database components

Figure 8.2 shows a database about a bookshop. There may be other tables, but three are shown in the database relating to the bookshop. One of the tables is called Order. Each table is made up of rows of records. Each table has columns with field names that describe the type of information that is stored in each field. In Figure 8.3, the Order table has three columns with field names CID, PR-ID and QTY, and seven rows of records. Each record therefore has three fields of data. The record in the fourth row of the Order table suggests that the customer with ID 1138 (Ed Yod) ordered 100 units of the product with ID P3745 (Receipt Book).

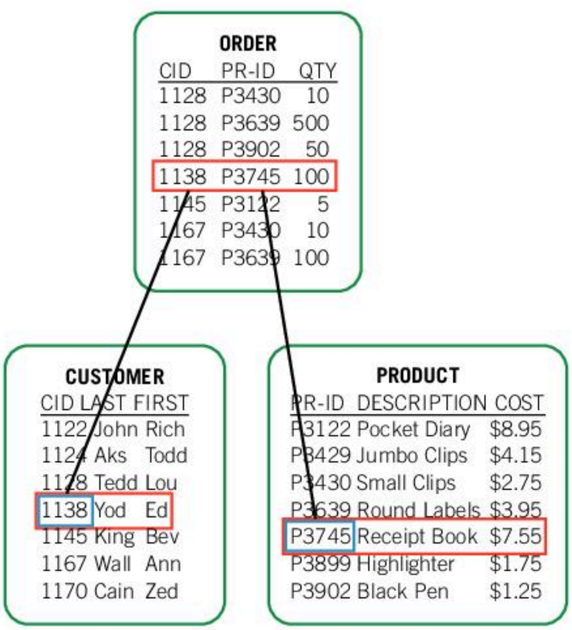


Fig 8.3 The data in the Order table links to data in other tables

The power of a database is that information contained in fields can be searched, grouped, sorted and/or exported – often in a matter of seconds. In Microsoft Access, you create a database by giving it a suitable name before you create the tables to enter the data. Table 8.2 illustrates the various components of a database.

Table 8.2 *Database terms and definitions*

Object	Components that make up a database (i.e. tables, forms, queries, reports, macros and modules)
Database	A database can consist of multiple tables
Table	A collection of records about a specific topic, such as students or vehicles
Query	Asks specific questions about the data in the database
Form	A graphical user interface designed specifically for entering, displaying, and searching data. This is an alternative to entering data in the spreadsheet-like view
Report	Summarises and formats data from either table or query data

Creating a table

Before you create the database and its tables, you must first choose an appropriate name for the database that describes its purpose. Then, provide suitable names for the tables based on the type of records that will be stored in them.

For each table in the database, you should consider the following components:

- field name, which identifies the data stored in a field
- field type, also called data type, which tells the database program what kind of data goes in the field, such as text, numbers or dates
- field length, which determines the size of each field in the table
- field description to allow you to describe the purpose of the field
- field properties, which include checks that the data is valid.

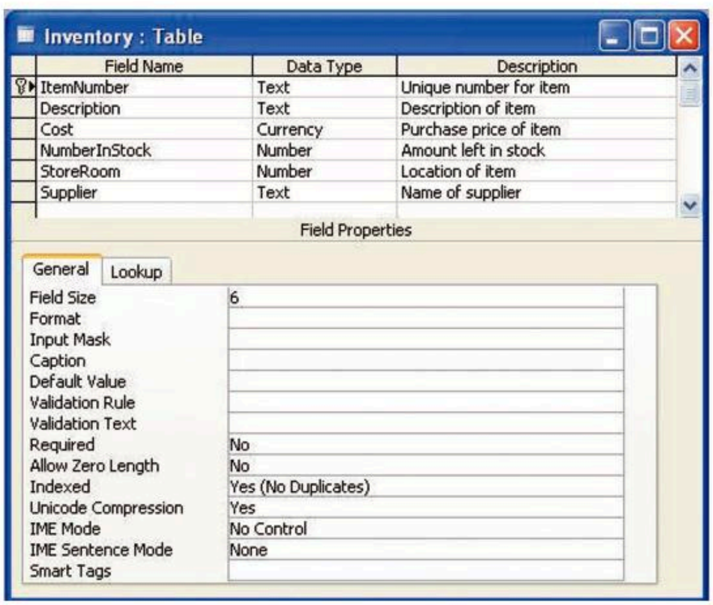


Fig 8.4 When creating a table, it is important to have the correct field name, type, length and description

Field name

The name of each field which identifies the data should be meaningful. For example, you should not have a field labelled 'Name', since you would not know if it is referring to a first name or a last name of someone, a product or a country. The Order table (Fig 8.3) contains three field names – CID, PR-ID and QTY. In some database programs a dash or an underscore is used if more than one word makes up a field name, such as First_Name. In others they can be written together, as FirstName.

Data types

The data type determines what kind of data can be entered as well as what operations the database can perform with the data. Again, using the Bookshop example in Figure 8.3, the field CID would be of type Text (also known as character or alphanumeric), but QTY would be a Number. It is therefore important to work out the data types for each field. The most common data types are shown in Table 8.3.

Table 8.3 *Common data types found in tables*

Use this type ...	*When the field's data is ...*
Text (Memo has been renamed as Long Text)	Long or short text – letters, numbers and special characters
Number (also known as a numeric field)	Numbers, for example 12345
Date/Time	Date – day, month and year information (for example, 26/08/1992) including time information (for example, 9:32)
Currency	Dollar-and-Amounts of money – $ (Dollar) or £ (Pound) or € (Euro)
Autonumber	A number that increases automatically as each record is added
Yes/No (also known as a Boolean or logical field)	Only one of two values (for example, a checkbox to tick, Yes/No, True/False, On/Off)
OLE Object	Picture, video clip, sound file or object from another program (Windows only)
Lookup Wizard	A drop-down box that offers you a limited choice of options for a data entry
Hyperlink	Web address that links to a web page
Attachment	An image, spreadsheet file, document, chart or other type of supported file that can be attached to a record; similar to attaching a file to an email message

Field length

Another important field attribute is field length. Not all database tables require you to set a maximum field length, but many do. This is because, if you decide in advance the maximum length of a field, the file size can be kept as small as possible and there is no wasted storage space. Also, the time taken to process data is kept to a minimum.

Think what you would have to do when setting the field length for a surname field. A field length of four characters would be right for those whose surname contains four characters, such as 'Glen', but not suitable for 'Ronald' (six characters). Some tables allow fixed field lengths – for example, 30 characters. The field stays 30 characters long even when the name Smith (5 characters) is entered.

Field description

You can enter an optional description for each field in the Description column in the design grid. The description appears on the status bar when the field is accessed on a form. Examples of a description include entering brief comments about the purpose of the field or the data that should be stored in it.

Field properties

Each field has a set of properties that control the way it stores, handles and displays data. You normally set properties when you create a table in Design view . However, you can display the Design view at any time to set or change any property settings.

The properties available in the Field Properties pane of the Design view window (Fig 8.4) depend on the data type selected in the design grid. Some of the property types are listed in Table 8.4.

Primary key

Usually one particular field of each record contains an item which is used to identify the record. This field is called the **primary key field** . This value in the key field must uniquely identify each record. Using the Bookshop example, the CID field in the Customer table can be used to uniquely identify each customer. You would not use First or Last field names, as more than one person may have those names.

The need for a key field becomes clear when you think of what might happen if you wanted to search a database for John Smith. Smith is a common surname and you may find that there are lots of Smiths in your database – and more than one John! It is better, therefore, to have a unique reference such as an identification number (key field) on which to search.

Table 8.4 *Property types for fields in a database table*

Property type	***Description***
Field Size	Limits a Text field to a specific number of characters or a Number field to the range of numbers it can store
Format	Controls the way data appears in Datasheet view
Decimal Places	Displays a set number of decimal places in Number and Currency fields only
Input Mask	Sets a pattern that determines the input format of data, such as the hyphens in a telephone number, for example 224-5860
Caption	Specifies a label other than the field name that appears in the table and on forms and reports
Default Value	Displays a specified value for a field in new records
Validation Rule	Limits the data entered to meet a certain requirement. For example, you can specify that the CustomerID field cannot be less than 1000
Validation Text	Specifies the text you want to appear in an error message if the data entered violates the validation rule. For example, the error message 'Customer IDs start at 1000' will pop up if you enter, say, 900 in the CustomerID field
Required	Specifies that the field cannot be left empty when you enter data into a record
Allow Zero Length	Determines whether or not you can enter quotation marks (" ") in a field to indicate that there is no data for that field in the record
Indexed	Speeds up retrieval of data in a field. All primary key fields are automatically indexed

Other unique keys

A **candidate key** can also be a primary key if it is unique. However, only one field must be chosen as the primary key. Candidate keys are entirely optional, so a table may contain none, one or several of them.

A **composite key** is a primary key that made up of two or more fields. In the Bookshop database, CID cannot be a primary key in the Order table as there are multiple occurrences of 1128 and 1167 in that column. Also, PR-ID cannot be a primary key in the Order table either because P3430 and P3639 are also listed more than once. Therefore, Figure 8.5 shows a composite key using two fields CID and PR-ID. This is done so that a customer can order more than one product and more than one customer can order the same product.

Order

Field Name	Data Type	
CID	Short Text	Customer ID
PR-ID	Short Text	Product ID from inventory
QTY	Number	Quantity ordered

Fig 8.5 A composite key is a primary key that can comprise multiple fields

In a database where the same field is found in two or more tables, if it is a primary key in one table, then it is a **foreign key** in the other tables.

Questions

1 Put the following terms in order from largest to smallest: database, field, record, table.

2 Explain what descriptions can be used for the following and whether they are suitable field names: last, first, PR_ID, CID.

3 State whether use of the following field names represent use of a primary key, candidate key, composite key or foreign key:
- **a** student ID printed on a student's school report
- **b** student ID printed on a student's exam card
- **c** product code used to identify the name of product
- **d** subject code printed next to each subject on a student's exam card
- **e** school code on a list of the subjects offered at the school
- **f** passport ID to collect student's exam card
- **g** driver's licence ID to collect student's school report
- **h** student's ID and subject code requested to receive student's grade for that subject.

4 Explain why a primary key (such as StudentID) that comprises all numbers would be given a data type of text and not number.

5 Identify a suitable data type for the following fields:
- **a** subject ID
- **b** mobile number
- **c** name of school
- **d** days absent from school
- **e** lives with mother?
- **f** centre code
- **g** day of exam
- **h** vehicle registration number
- **I** receipt number
- **J** quantity ordered.

6 It is important to plan the structure of a database carefully before you start creating one. The following table is to contain information on members of your family. 'Relation' represents what relation this member is to you, such as sister, uncle or self (meaning yourself!). 'Adult' states whether this member is an adult or a child.
- **a** Choose the most suitable field type for each field (see Table 8.3, which shows different field types).
- **b** Choose the maximum field length for each field.
- **c** Explain whether a field in the list can be used as a primary key. If not, explain what field can be created as the primary key field.

Field	Field type	Field size	Key field?
LastName			
FirstName			
Relation			
Month of Birth			
Male?			
Adult			

Practical exercises using Microsoft Access

Exercise 1: Creating a database

1 Start the Access program by double-clicking on the Microsoft Access icon. These icons may look different depending on your version of Access.

2 Access requires you to provide a name for the new database, or you can browse to open an existing database. Select the option to create a new database and type the name Bookshop. Note that this database is saved in your Documents folder if you do not specify another location.

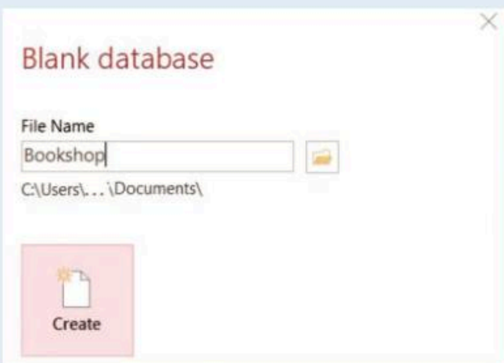


Fig 8.6 Creating a database called Bookshop

Exercise 2: Creating a table

1 Now that you have created the Bookshop database, it is time to create a database file called a table. Depending on the database program you are using, an empty table, labelled as Table1, may be created for you. If so, then right-click on its label to close and delete it.

2 Microsoft Access provides options to create a table, query, form or report. The Bookshop database will require three tables, called Customer, Product and Order. Each table is created in Design view.

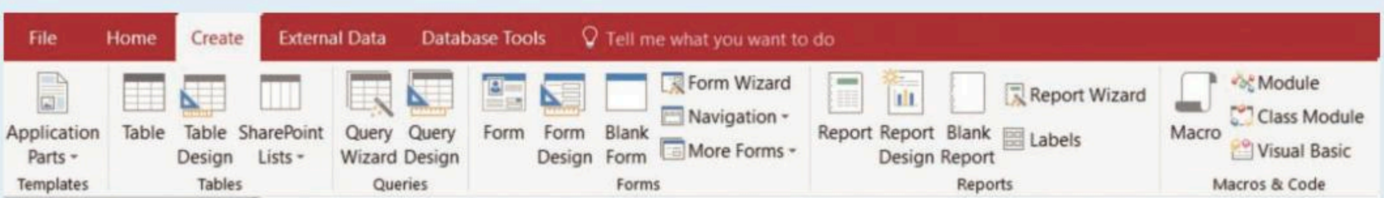


Fig 8.7 Microsoft Access provides options to create a table, query, form or report

3 To create the first table (called Customer), locate the icons or labels that will allow you to Create a Table and view its design. For now, the new table is called Table1.

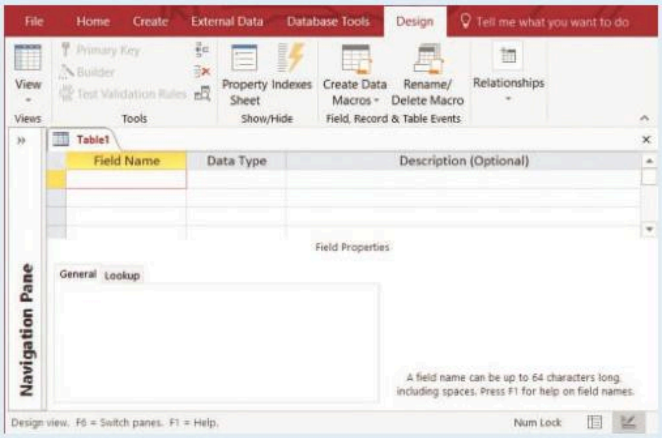


Fig 8.8 Start with a blank table in Design view

4 Click in the first Field Name box and type 'CID', then press *Enter*. In the Data Type column, choose the Text type, press *Enter* and then type the description as 'Customer ID'. Click below to the Field Properties area to type 4 for the field size. Enter the following field names, types and descriptions in your table.

Field name	Field type	Description
CID	Text	Customer ID Number
Last	Text	Customer's Last Name
First	Text	Customer's First Name

5 Note that the CID field is Text, since calculations are not performed on this field, otherwise the Number data type would be chosen. Click again on the CID field name and enter the following field properties:
Field Size: 4
Validation Rule: >999
Validation Text: Customer IDs start at 1000

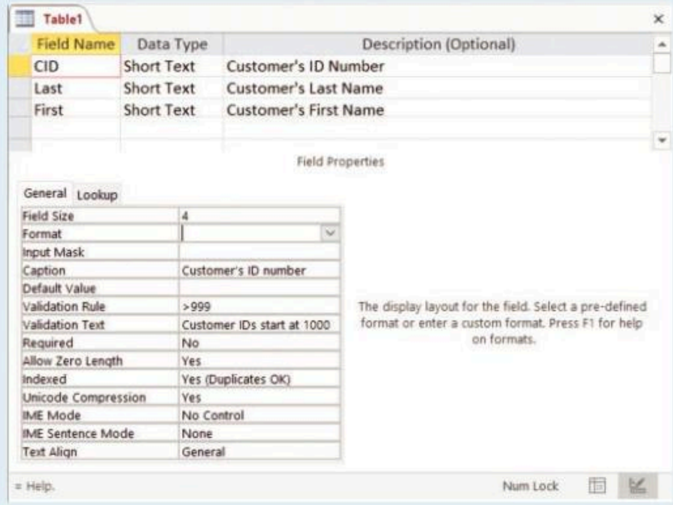


Fig 8.9 Entering the design of the Customer table

6 At this point, you should choose one field whose value uniquely identifies each record in a table. If you do not define a primary key, Microsoft Access asks you if you would like to create one when you save the table. For this exercise, make the CID field the primary key, meaning that every item has a four-digit number and no two are the same. To do this, select the CID field and select the Primary Key icon . Then click the Save icon or *Ctrl* + *S* to save the table. Name the table as Customer and click OK to close the dialogue box. You have created your Customer table.

7 Use the same Bookshop database. Locate the icons or labels that will allow you to Create a Table and view its design.

8 Enter the following field names, types and descriptions in this table.

Field name	Field type	Description
PR-ID	Text	Product ID
Description	Text	Description of product
Cost	Currency	Unit cost of the product

9 Make PR-ID a primary key and save the table as Product.

10 Use the same Bookshop database to create another blank table in Design view. This will be used to create the Order table.

11 Enter the following field names, types and descriptions in this table.

Field name	Field type	Description
CID	Text	Customer ID
PR-ID	Text	Product ID from inventory
QTY	number	Quantity ordered
DISCOUNT	Yes/No	10% discount offered on Product

12 Make CID and PR-ID the composite primary key. Select the CID row, then while pressing the *Shift* key, select the PR-ID row. Then click the Primary Key icon in the Menu bar. Both fields will have the Primary Key icon next to them.

13 Save the table as Order.

Tables should be joined, so that you can access and coordinate information in all the fields of the connected tables. Joining tables saves you having to enter the same information in several tables. In addition, it allows you to create reports, forms and queries from the related data tables in the database file. This means you can create smaller, more efficient tables that can be related when you need access to the data.

Relationships

The linking of two tables can occur in one of two ways:

- one-to-one
- one-to-many.

One-to-one (1:1)

This type of linking usually takes place when the primary key in one table matches the primary key in the second table. An example of *one-to-one* linking is that each employee has a personnel record, or a personnel record is created on each employee. In Figure 8.10 there is one record in the Employee table that links with one other record in the PersonalRecord table.

One-to-many (1:M)

This occurs when one primary key in one table links with a foreign key or a combined key in another table. That is, a record in one table matches many records from the other table. For example, one department has many employees, or many employees are assigned to one department. This is shown in Figure 8.10, where one record in the Department table can have many matching records in the Employee table.

In applications such as Microsoft Access, the linking of tables is called a relationship. A one-to-one relationship is shown in Figure 8.10 by a line connecting the two entities with 1 denoting the 'one' ends of the relationship. A one-to-many relationship is shown with M or an infinity sign (∞) denoting the 'many' end of the relationship. Although there are other conventions in many texts, you should use one that you understand best.

Using the Bookshop database example with the Customer, Product and Order tables, how do you identify who has ordered which product? This is achieved by linking pairs of tables that have a field common to both tables. There is related data in these tables, since a customer can place one or more orders for a product. Figure 8.11 shows three tables again with their fields. The primary key field is underlined in each table.

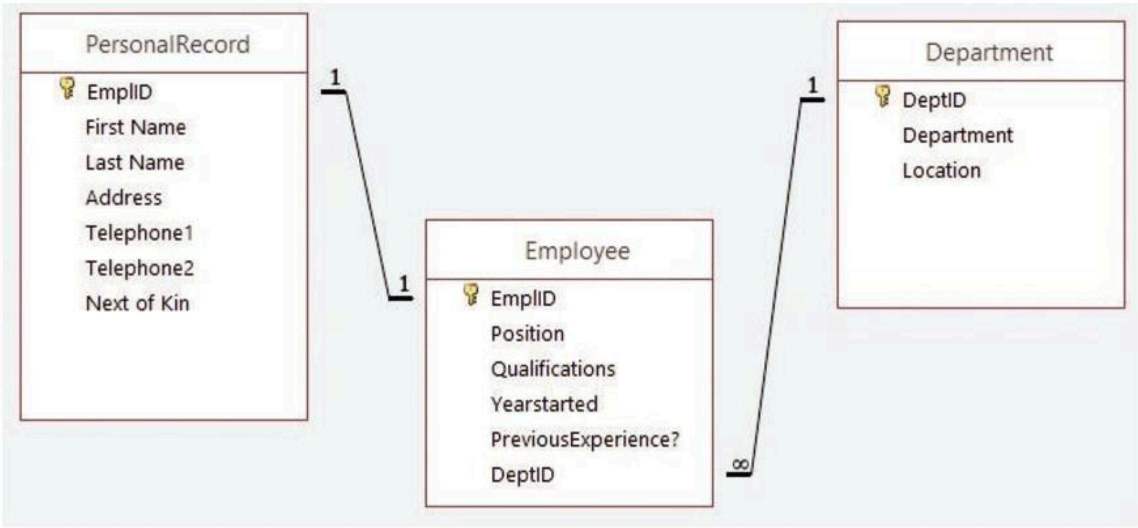


Fig 8.10 Linking common fields between pairs of tables

CUSTOMER		
CID	LAST	FIRST
1122	John	Rich
1124	Aks	Todd
1128	Tedd	Lou
1138	Yod	Ed
1145	King	Bev
1167	Wall	Ann
1170	Cain	Zed

PRODUCT		
PR-ID	DESCRIPTION	COST
P3122	Pocket Diary	$8.95
P3429	Jumbo Clips	$4.15
P3430	Small Clips	$2.75
P3639	Round Labels	$3.95
P3745	Receipt Book	$7.55
P3899	Highlighter	$1.75
P3902	Black Pen	$1.25

ORDER		
CID	PR-ID	QTY
1128	P3430	10
1128	P3639	500
1128	P3902	50
1138	P3745	100
1145	P3122	5
1167	P3430	10
1167	P3639	100

Fig 8.11 Creating a relationship between pairs of tables for the Bookshop database

Linking tables ensures that the data in the database remains as accurate as possible. For example, if you wish to delete a customer who has placed orders, the database will not allow you to do so until the orders for that customer are deleted. That way, no order can be placed without having a customer's data linked to it.

Questions

1 Use Figure 8.11 to answer the following questions:

- **a** State whether pairs of tables have a one-to-one relationship or a one-to-many relationship.
- **b** State the primary key in each table.
- **c** State the first names of the customers who ordered round labels.
- **d** State the description of the product that was ordered by the customer with ID 1145.
- **e** How many customers placed orders?

2 Answer the questions based on these two tables in a Sports database:

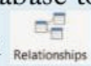
ATHLETE			
AthleteID	**NameOfAthlete**	**Code**	**Gender**
121	Jade Boyce	U13	F
231	Shade Skeete	U13	F
351	Neil Hall	U20	M
142	Figman McJig	O20	M
187	Eli Jarad	U20	M

DIVISION	
Code	**Category**
U13	Under 13
U20	Under 20
O20	Seniors

- **a** State the names of the tables.
- **b** How many records are in the Athlete table?
- **c** How many fields are in the Division table?
- **d** In each table, state the most appropriate field that can be used as a primary key.
- **e** State the name of the table and the field that is a foreign key.
- **f** Identify the field that is used to link the tables.
- **g** Explain whether the tables are linked as one-to-one or one-to-many.
- **h** Explain whether the row for the Under 13 division can be deleted from the Division table.
- **i** Explain whether the row of data for athlete 142 can be deleted from the Athlete table.
- **j** Write the name(s) of the seniors.
- **k** What division is Athlete 231 in?

Practical exercises using Microsoft Access

Exercise 3: Linking tables in the Bookshop database

1 Open the Bookshop database that was created in exercises 1 and 2. Locate the Database toolbar that contains the Relationships icon .

2 Click on the Relationships icon, then click the Show Table icon  on the toolbar to make it appear.

3 Double-click on the Customer, Product and Order tables. When you have finished adding the tables, click Close.

4 Now click on the CID field in the Customer table and drag it to the CID field in the Order table.

5 An Edit Relationships window pops up (Fig 8.12). Make sure the Enforce Referential Integrity option is ticked in the checkbox and press OK. This means that Access will help you enforce rules so that your data is valid to start with and remains valid throughout its use.

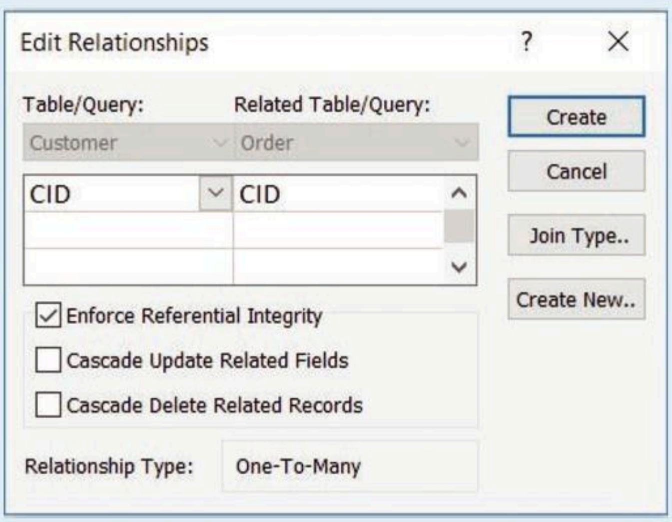


Fig 8.12 Enforcing rules on your data

6 You have created a relationship between the Customer and Order tables.

7 Repeat the procedure in steps 4 to 6 to create a relationship between P-ID in the Product table and P-ID in the Order table.

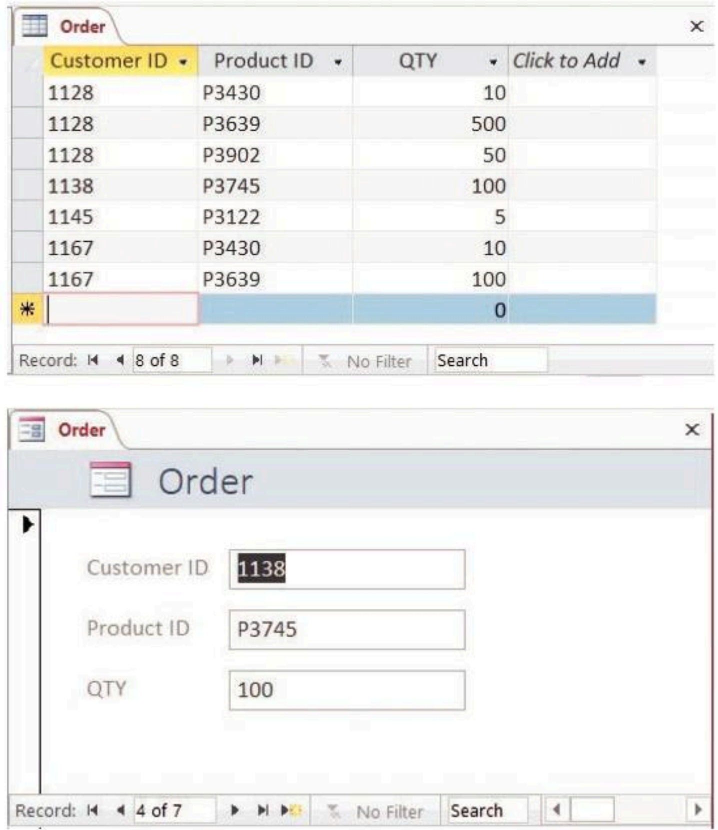
Exercise 4: Linking tables in other databases

1 Return to the previous example on the Sports database.

2 Create the database called Sports, and then create the two tables.

3 Link the tables using a common primary key, and enter the data in each table.

You can start entering data once you have completed the table design. Design view  allows you to enter field names, data types and descriptions into your database table. Another view, Datasheet view  allows you to enter raw data into each field of your database table. If you have selected a field as a primary key, make sure that there is always data in this field. To switch views between the Datasheet and the Design view, simply click the button in the top-left hand corner of the Access program window.


Order

Customer ID	Product ID	QTY	Click to Add
1128	P3430	10	
1128	P3639	500	
1128	P3902	50	
1138	P3745	100	
1145	P3122	5	
1167	P3430	10	
1167	P3639	100	
*		0	

Fig 8.13 You can enter data using a datasheet (top) or a form (bottom)

A form is another way to enter data (Fig 8.13). It is a graphical representation of a table where you can also add, update and delete records in your table as with the datasheet. You can give the form a different name from your table, but they both still work on the same information and the same data. This means if you change a record in a form, it will also be changed in the table.

A form is very good to use when you have many fields in a table. It means you can see all the fields in one screen. If you were in the Datasheet view, you would have to keep scrolling to see a field at the far left or right.

Sometimes you may need to see one record and the related data on that record in one form. For example, you may wish to see all orders for one customer. It is useful to create a form of the customer data with a sub-form (Fig 8.14) showing the products ordered along with their costs, quantities ordered and whether they are on discount.

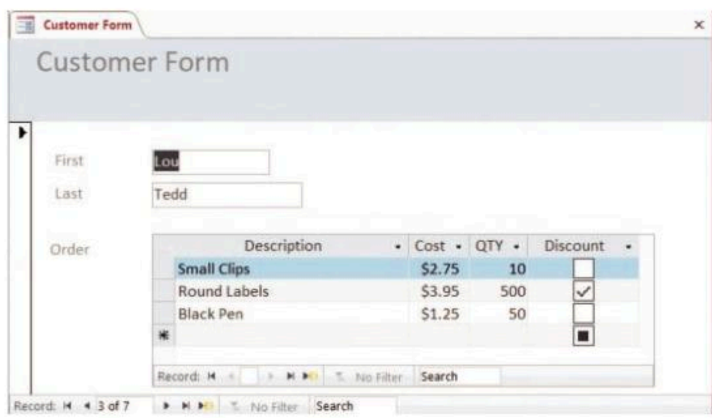


Fig 8.14 A form showing the customer's name along with a sub-form of the products ordered, their costs, quantities and whether they are on discount

Field options

Data entry should be as simple and quick as possible. This is particularly important if a database has hundreds or thousands of records. Data also needs to be accurate. To help with this, you can set the entry options for fields. One entry option is to get data to be automatically entered into a field. For example, the Quantity field could automatically enter the number 0 for each new record entered.

In most databases, you will also need to enter the same values into a field repeatedly. For example, it is much quicker and more accurate to choose a product from a list, rather than having to type it in each time. A value list (or combo box) lets you do this by choosing a value from a list (Fig 8.15).

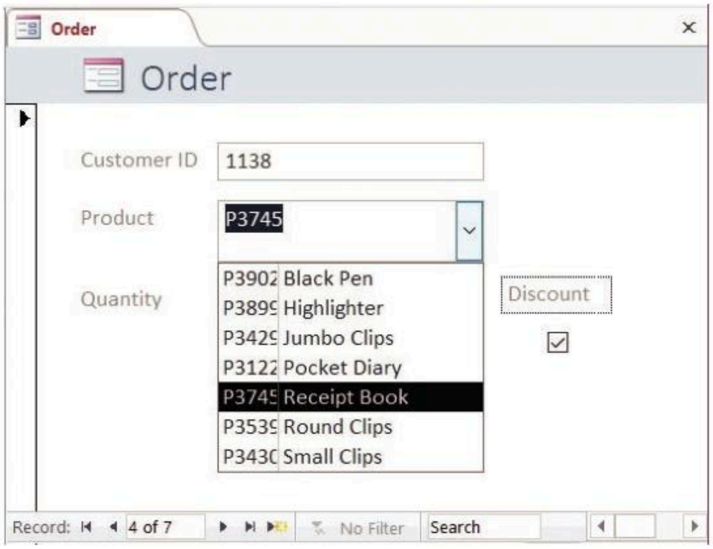


Fig 8.15 Value lists are a quick and accurate way to enter data. Here a list is shown where only one product can be selected. A check box determines whether a product is eligible for a 10% discount

Other entry options include a check box (Fig 8.15). Instead of typing Yes or No in a field, you can have a check box where a tick means 'Yes' and the absence of a tick means 'No'. Another option is to have radio buttons, also known as option buttons. These methods of data entry reduce the possibility of error when inputting data.

Questions

1 Explain the difference between Datasheet view and Design view when creating a table.

2 State the name of the graphical representation of a table that allows you to quickly add records.

3 State two data entry options that can be used to quickly and accurately enter data in a database.

Practical exercises using Microsoft Access

Exercise 5: Entering data

1 Open the Bookshop database that was created in Exercise 1.

2 Double-click on the Customer table to open it.

3 To switch views between the datasheet and the Design view, simply click the button in the top-left hand corner of the Access program window.
- Datasheet view : allows you to enter raw data into your database table
- Design view : allows you to enter fields, data types and descriptions into your database table.

4 Click on Datasheet view and enter the data shown below into the Customer table and save it.

CID	Last	First
1122	John	Rich
1124	Aks	Todd
1128	Tedd	Lou

- To add a new row, press *Enter* or select the next line and enter the information.
- To modify a record if you have made an error, select the record and field you want to update, and replace it with the text you want.
- To delete a record, right-click on the row and select Delete Record (Fig 8.16).

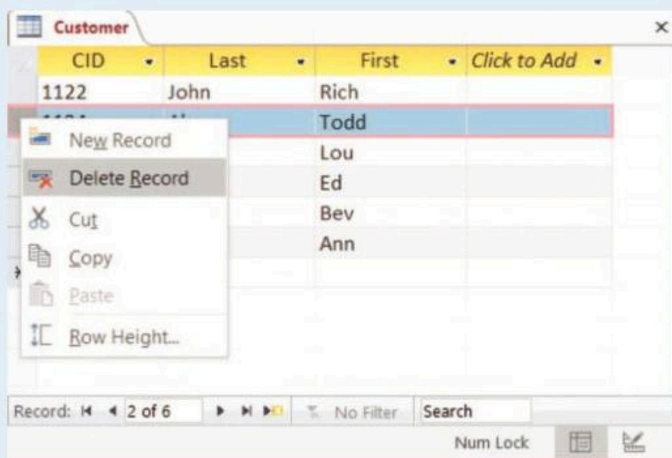


Fig 8.16 Deleting a record from the Customer table

5 Click on the first record again and change the CID to 112. Press *Enter* and you should see your validation rules working (Fig 8.17).

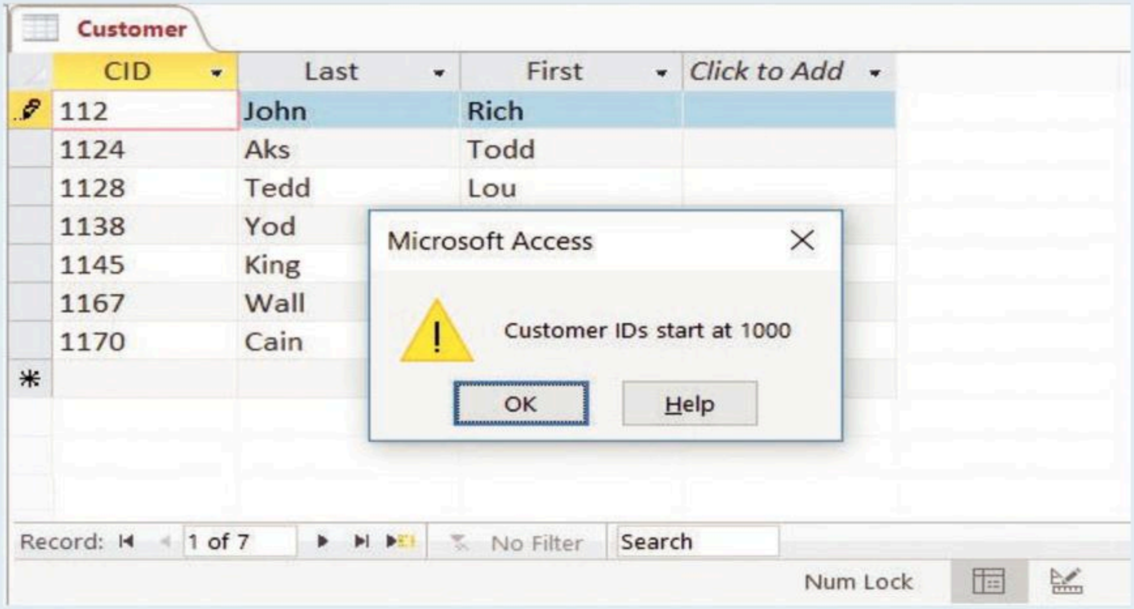


Fig 8.17 Entering a number that is not valid results in an error message

6 Select the Product table and double-click to open it.

7 Enter the following records:

PR-ID	Description	Cost
P3122	Pocket Diary	$8.95
P3429	Jumbo Clips	$4.15
P3430	Small Clips	$2.75

8 Select the Order table and double-click to open it.

9 Enter the following records:

Customer ID	Product ID	QTY	Discount
1128	P3430	10	
1128	P3639	500	Y
1128	P3902	50	

Exercise 6: Create a basic form

Microsoft Access does a very good job of creating a form, and even provides a Form Wizard for creating more complex forms. First, follow these steps to create a basic form:

1 Open the Bookshop database with the Customer, Product and Order tables. Each table should have three records of data.

2 Select the Customer table. Then in the menu or ribbon, select the Create tab and then the Form icon 

.

3 This option creates a simple form using all of the fields in the table.

4 Use the form to enter the following records in the Customer table:

CID	Last	First
1138	Yod	Ed
1145	King	Bev
1167	Wall	Ann
1170	Cain	Zed

Exercise 7: Create a form using the wizard

1 Select the Product table. Then activate the Form Wizard. In some versions of Access, there may be an icon Form Wizard, which can also be found in the More Forms option on the ribbon.

2 Select the fields needed for the form by selecting a table or query from the Tables/Queries drop-down menu. To select the fields you want to view on your form use the > arrow to move them from the Available Fields window in the left pane to the Selected Fields window in the right pane. You would use >> if you are selecting all of them (Fig 8.18).

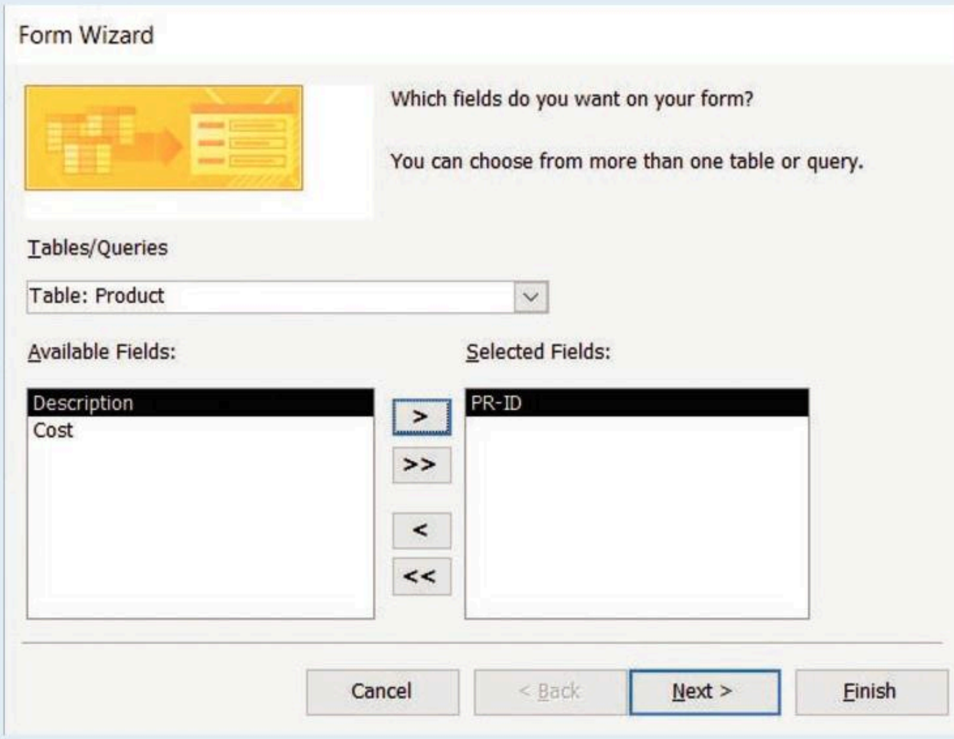


Fig 8.18 Using the Form Wizard to select fields

3 Click Next.

4 Select the layout you wish and click Next.

5 You may be asked to select the style you desire. Use a light background if you are going to print your form.

6 Click Next.

7 Give your form the name Product and click Finish.

8 You should see your form.

9 Enter the following data using the form:

PR-ID	*Description*	*Cost*
P3639	Round Labels	\$3.95
P3745	Receipt Book	\$7.55
P3899	Highlighter	\$1.75
P3902	Black Pen	\$1.25

Exercise 8: Completing the data entry with the Order table

1 Use the Form Wizard or another method to enter the following data in the Order table:

Customer ID	**Product ID**	**QTY**	**Discount**
1138	P3745	100	
1145	P3122	5	
1167	P3430	10	
1167	P3639	100	Yes

Exercise 9: Creating a form with a sub-form

1. Select the Customer table.
2. Activate the Form Wizard.
3. Select the fields needed for the form by selecting a table or query from the Tables/ Queries drop-down menu. Use the > arrow to move the CID, then First and Last field names from the Available Fields window in the left pane to the Selected Fields window in the right pane.
4. Practice adding additional fields from the tables so that the fields are selected in the following order:
   a. Select the Order Table and add the CID and PR-ID fields (Fig 8.19a).
   b. Select the Product Table and add the Description and Cost fields.
   c. Select the Order Table again and add the QTY and Discount fields.
5. Click Next.
6. If prompted, view the data by Customer. You will be able to see the form and sub-form in the preview pane (Fig 8.19b).
7. Click Next.
8. Leave the layout option of the sub-form as Datasheet and click Next.
9. Type Customer Form as the name of the main form and leave the name of the sub-form as Order sub-form (Fig 8.19c).
10. Click Finish to see the final form (Fig 8.19d).
11. Locate record 3 to view the orders for the customer Lou Tedd.
12. At the bottom of the form you will see Record: 3 of 7.
13. Add the following order for Lou Tedd. Click in the PR-ID and enter P3745. The Customer ID, description and cost of that product should fill in those fields. Enter 25 for the quantity and leave the discount blank.
14. Click the icon to add a new record. Enter the following record of data for a new order:
    CID: 1199
    First: June
    Last: Jarway
    PR-ID: P3745
    QTY: 25

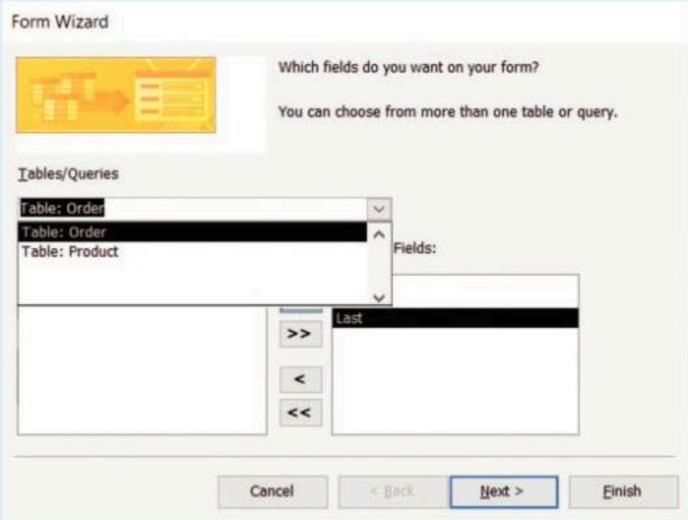


Fig 8.19a Selecting the Order table

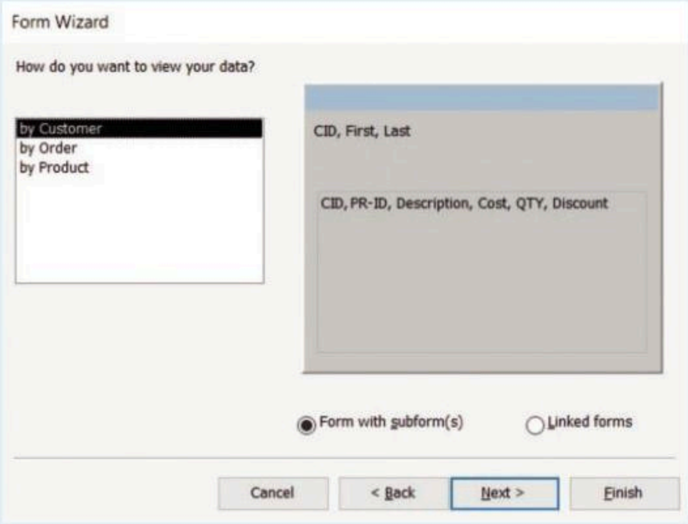


Fig 8.19b Viewing the data by Customer – you can see the form and sub-form in the preview pane

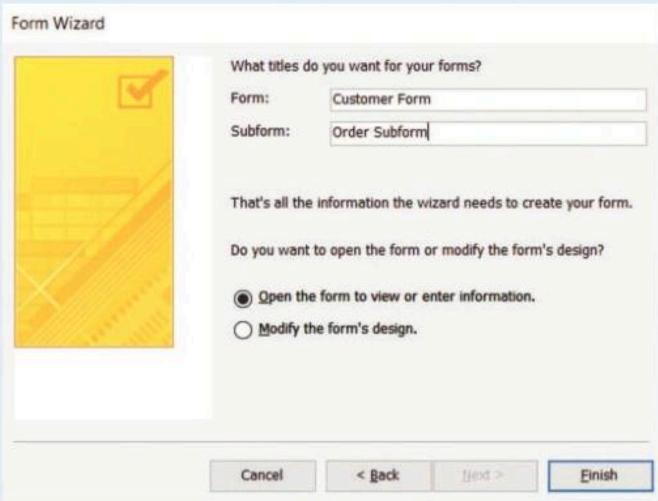


Fig 8.19c Naming the form and sub-form

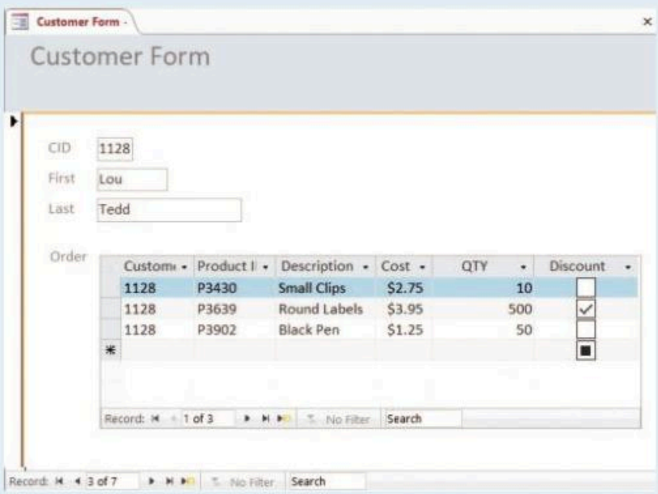


Fig 8.19d The final form showing the orders for customer Lou Ted

Exercise 10: Create a form for the Sports database that contains the Team and Division tables

TEAM			
AthleteID	**NameOfAthlete**	**Code**	**Gender**
121	Jade Boyce	U13	F
231	Shade Skeete	U13	F
351	Neil Hall	U20	M
142	Figman McJig	O20	M

DIVISION	
Code	**Category**
U13	Under 13
U20	Under 20
O20	Seniors

1. Create a database called Sports.
2. Create the two tables, choosing the most appropriate data types in each table.
3. Select a suitable primary key for each table.
4. Create a form to enter the data in the tables as follows:
   - Main form: Code and Category from the Division table
   - Sub-form: AthleteID, NameOfAthlete and Gender from the Team table.

Computers have important advantages over manual systems since they can work extremely quickly, and automatically, to make calculations and to retrieve and sort data into some useful form. All these functions are known as data processing.

Searching

Searching a database is reasonably straightforward once you realise that you must tell the program precisely what to search for. You do this by giving clear criteria (conditions) for the search. You might know what you want to find, but the software does not – until you tell it.

A **query** (also known as a filter or search) is used to answer a question using the data in a database. The database is searched to find all the records that match a particular condition. A query is the question you ask, such as 'List the first names of the customers who ordered round labels.'; it is not the results (for example, Ann and Lou).

You may make several queries to ask different specific questions. When a query is 'run' it produces as output a list of all the records that match the condition that defined the query. Once you have created a query, you can run it as often as needed. Even the results of the query will be updated if you add more data to the table.

When you begin to design your queries, ask yourself:

- What specific question do I want to ask?
- What data (fields) do I need displayed?
- What sort order will help me the most?

Queries can be as simple or as complex as you like. To search a database, you must first enter the search criteria into one or more fields for their tables. Then you instruct the program to find all the records that match the conditions that you have set. For example, to find the products with orders that are less than 50, you would type <50 in the QTY field of the Order table.

First	Description	QTY
Lou	Small Clips	10
Bev	Pocket Diary	5
Ann	Small Clips	10

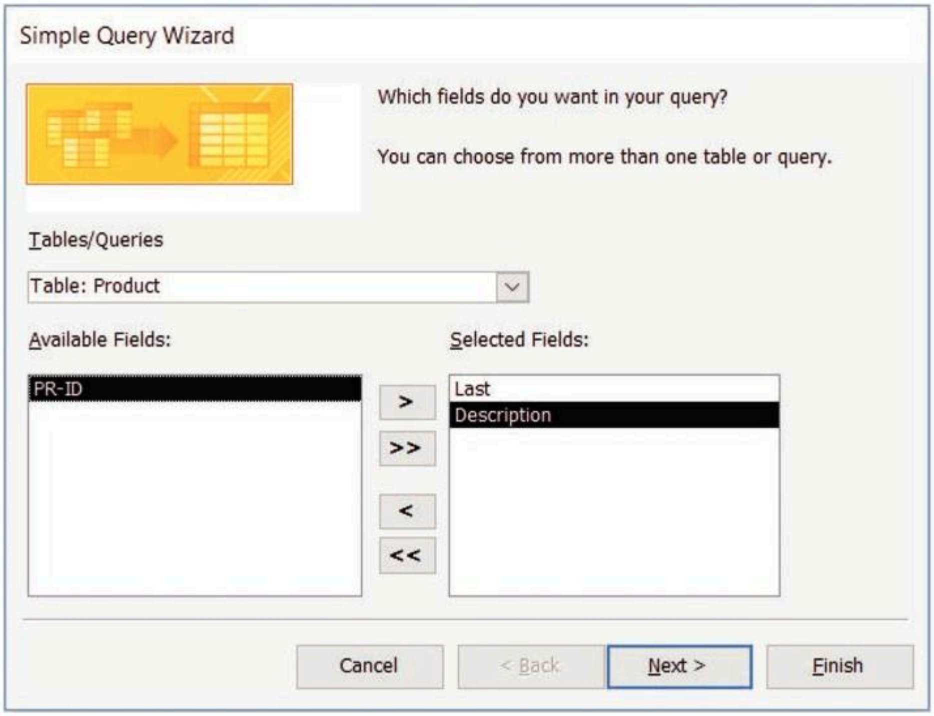


Fig 8.20 Using the Query Wizard to select fields in a query

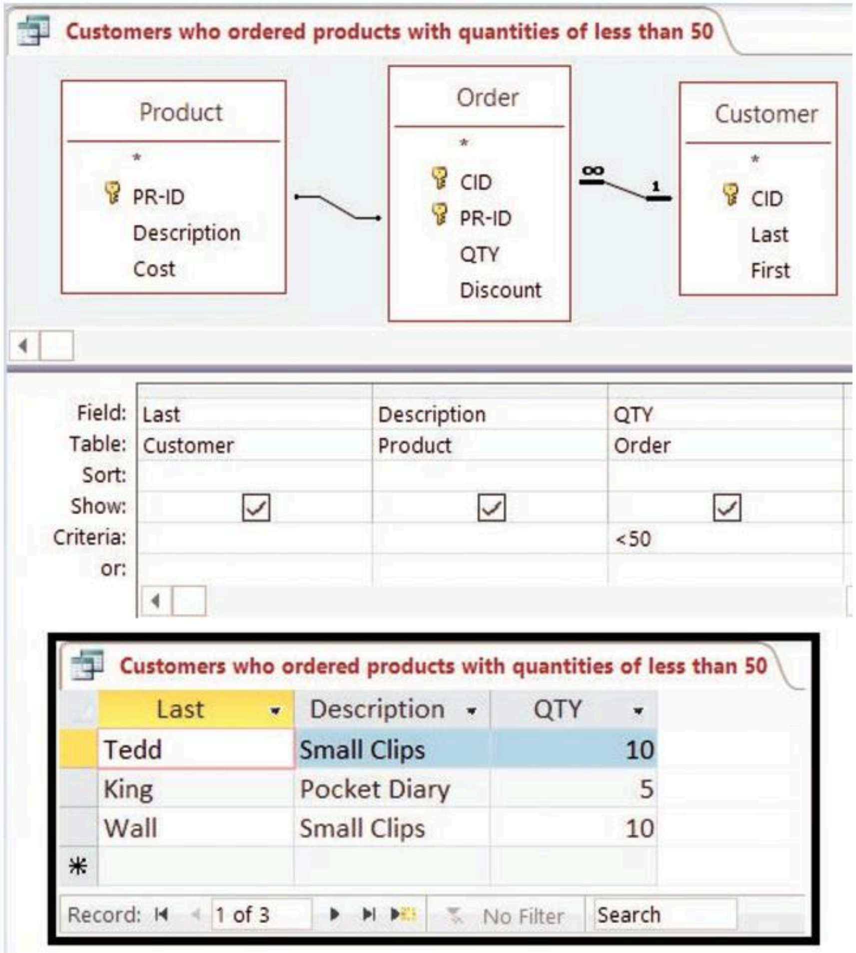


Fig 8.21 Creating a query to list the products with orders of less than 50

After executing the query, you may see one or more records that were produced from your search.

The comparisons that you can make in queries will depend on which database program you are using. Table 8.5 lists some common operators used.

Searching for specific records

The word 'criteria' in a database means you want to find only certain records and ignore others (the ones that do not meet the criteria conditions). If you want to limit the results of your query, you can set up specific criteria. If a record meets those criteria, it is included in the results. Note also in Table 8.5 that the criteria does not include any formatting such as the dollar sign ($) or percentage symbol (%). Any search using text as the criteria is enclosed in double quotation marks. For example, suppose you wish to find the product with ID P3430. This produces one result: Small Clips costing $2.75. Figure 8.22 illustrates how you place P3430 in the criteria row below the field name where you wish to find the specific records. The other fields can be selected (ticked) to indicate that you wish to see their results as well. If you only wish to see the product description and the costs, make sure only those two fields are selected.

Table 8.5 *Operators used in searching databases*

Operator	*Meaning*	*Example*
=	Equal to	"P3122" searches the product ID number field to find all products with that identical product ID
>	Greater than	> 5 searches the cost field to find all products that cpst more than $5.00
<	Less than	< 5 searches the cost field to find all products that cost less than $5.00
>=	Greater than or equal to	>= 5 searches the cost field to finds products whose cost is greater than or equal to $5.00
<=	Less than or equal to	<= 5 searches the cost field to find products that cost less than or equal to $5.00
*	Asterisk, known as a wild-card character, can be used to represent one or more characters	"R*" or like "R*" will find all products whose first character or letter begins with R, for example Receipt books and Round labels

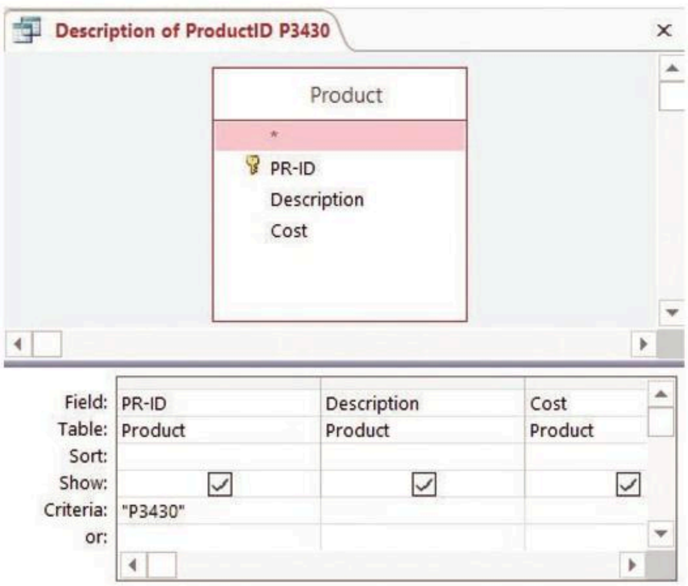
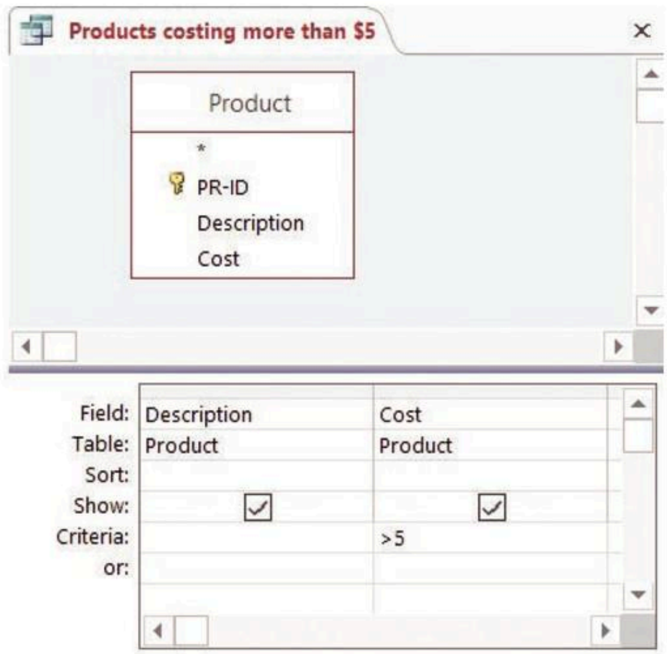


Fig 8.22 Searching for a description for product P3430



Description	Cost
Pocket Diary	$8.95
Receipt Book	$7.55

Fig 8.23 Query to find products that cost more than $5.00 and its result

Also notice that there is only one table selected. If the fields you need for the query are found in one table then the other tables should be deleted from the query. Otherwise you may find duplicate records in your result. To delete a table in query design, select the table, right-click and select remove table or select the table and press the *Delete* key on your keyboard.

Figures 8.23 and 8.24 show other examples of how to find products that cost more than $5.00 (Fig 8.23) or those that begin with 'R' (Fig 8.24).

Queries using more than one field

You can create more complicated queries by linking together more than one search condition. For example, find the customers who ordered products costing less than $5 in quantities of more than 100. Figure 8.25 shows how in Microsoft Access <5 and >100 are placed on the same criteria row but under their field names. This joins the two queries with the AND operator.

Another query finds the customers who ordered products costing less than $5 OR products with quantities of more than 100. Figure 8.26 shows how in Microsoft Access <5 and >100 are placed on two lines labelled as 'criteria' and 'or'. It does not matter which one is entered in the criteria or the OR row once they are not in the same row. This joins the two queries with the OR operator. The result below can be saved as Less than $5 or More than 100.

First	Description	Cost	QTY
Lou	Small Clips	$2.75	10
Ann	Small Clips	$2.75	10
Lou	Round Labels	$3.95	500
Ann	Round Labels	$3.95	100
Lou	Black Pen	$1.25	50

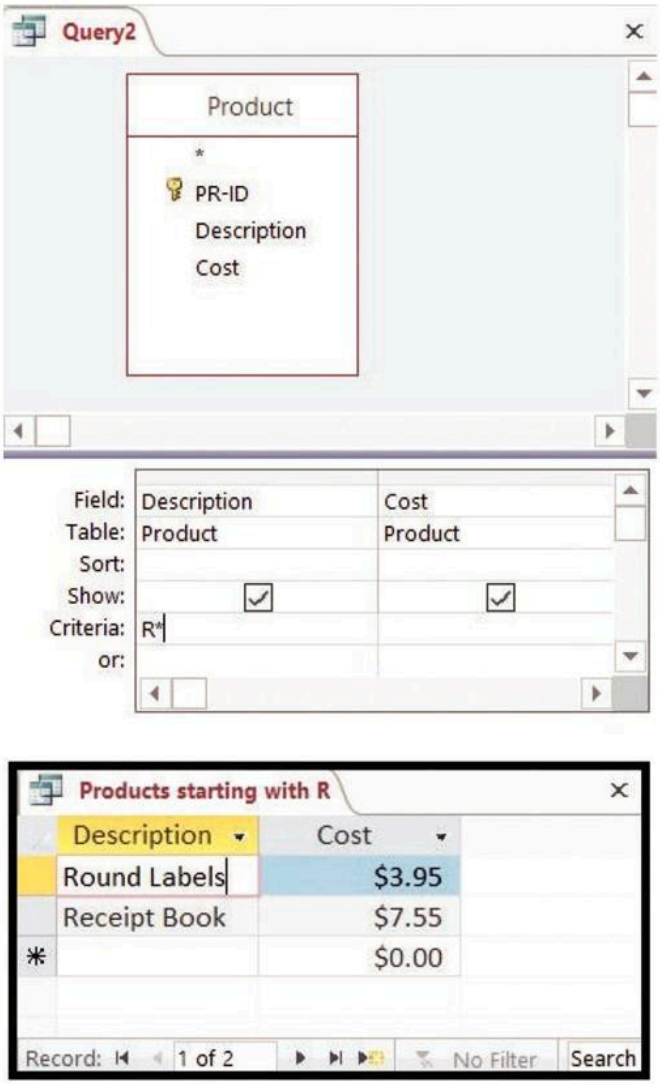


Fig 8.24 Query to find the names of products that begin with 'R' and its result

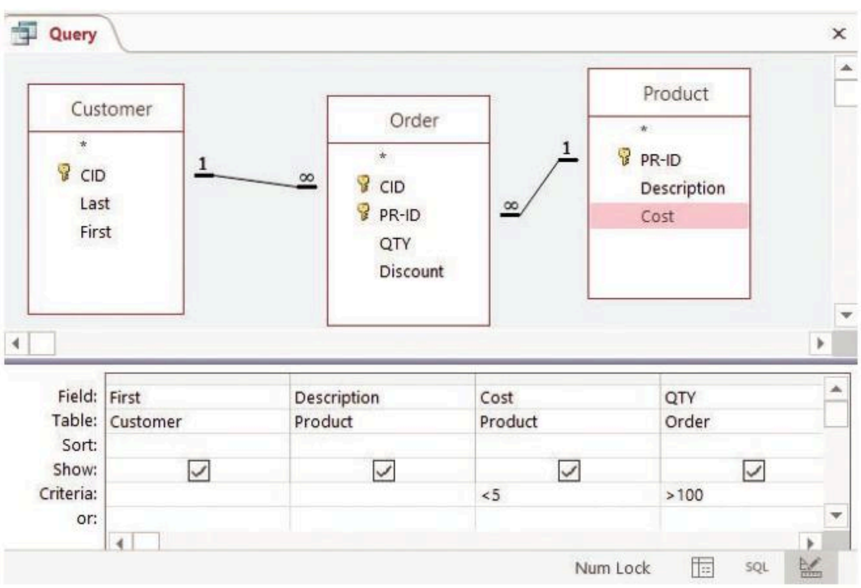


*Fig 8.25a Query to find the customers who ordered products **costing less than** $5 in quantities of more than 100*

Fig 8.25b results from query to find the customers who ordered products ***costing less than*** *$5 in quantities of more than 100*

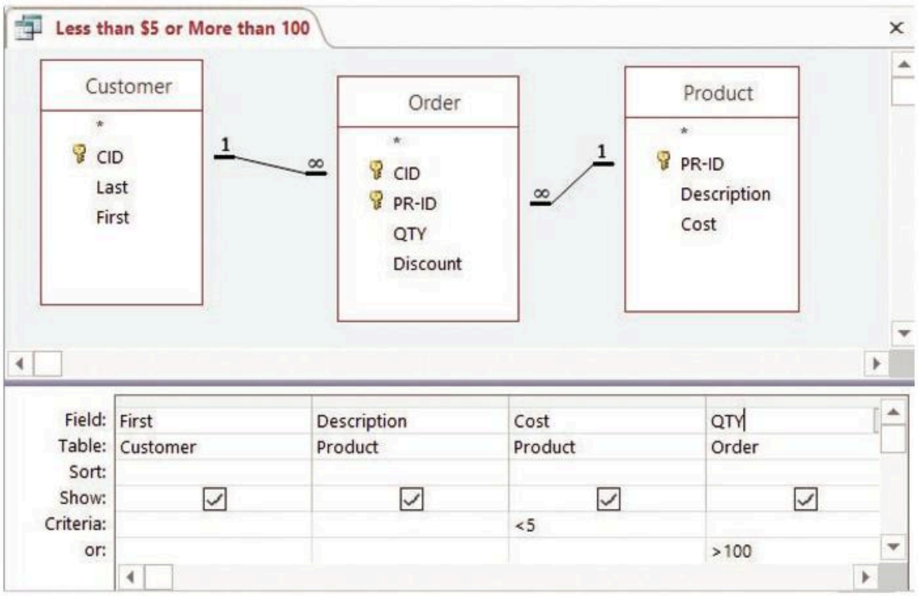


Fig 8.26 Query to find the customers who ordered products costing less than $5 OR quantities of more than 100

Notice that in these queries all three tables were used since fields were needed from each table. However, if fields from the Customer and Product tables were needed, the Order table should not be deleted since it is linking these two tables in the database. For example, suppose the Bookshop needed to contact all customers who ordered Black Pens. The First and Last field names would be selected from the Customer table, while the Product ID (PR-ID) or Description for the Black Pens could be selected from the Product table and not the Order table.

The words AND and OR are the only ones that can be used to link two simple conditions together to make a more complicated query. The difference between using AND or OR to join two conditions is:

- AND: Find only records which match *both* of the conditions.
- OR: Find records that match *either* or *both* of the conditions.

Reversing queries

Sometimes you may want to search for records which do not match a particular criteria. For example, you may want to find all customer orders except those for customer Lou. The keyword NOT is used to do this (Fig 8.27a).

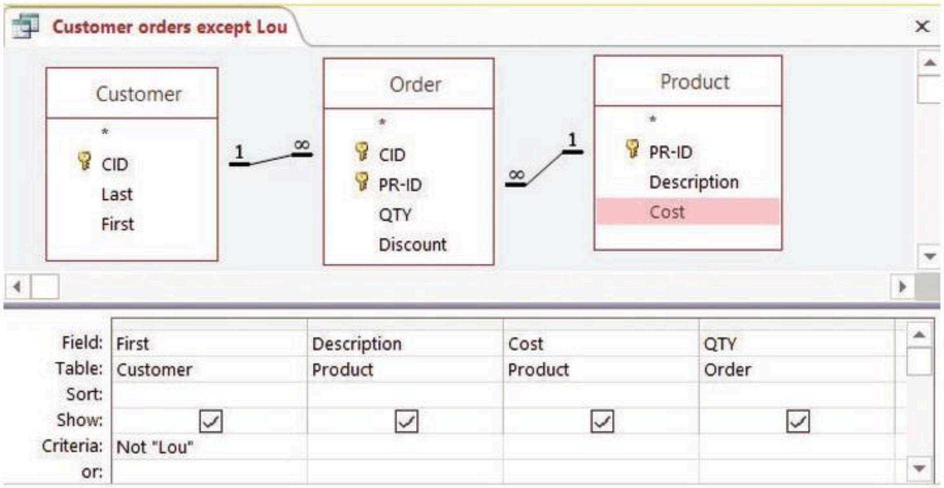


Fig 8.27a Query to find all orders NOT placed by Customer Lou


Customer orders except Lou

First	Description	Cost	QTY
Ed	Receipt Book	$7.55	100
Bev	Pocket Diary	$8.95	5
Ann	Small Clips	$2.75	10
Ann	Round Labels	$3.95	100

Record: 1 of 4 No Filter Search

Fig 8.27b Result of query to find all orders NOT placed by Customer Lou

Sorting

Most databases will let you sort data so that it is displayed in a specified order. To sort a database into an order you must specify:

- which field in the database you wish to use to order the records
- whether you want the records in ascending (A to Z) or descending (Z to A) order.

Sorting records temporarily reorders the database file. Sorting allows you to browse, update, export or print records in a particular order. You can also sort numbers, dates and times in ascending and descending order. Being able to sort records quickly is one of the advantages of using a database. Depending on your version of Microsoft Access, you may have one or more methods of sorting your data. However, the result remains the same. The following three examples show how your results can be sorted by the last name field in ascending order.

Figure 8.28 shows how the sort option in Design view is used to order the data.

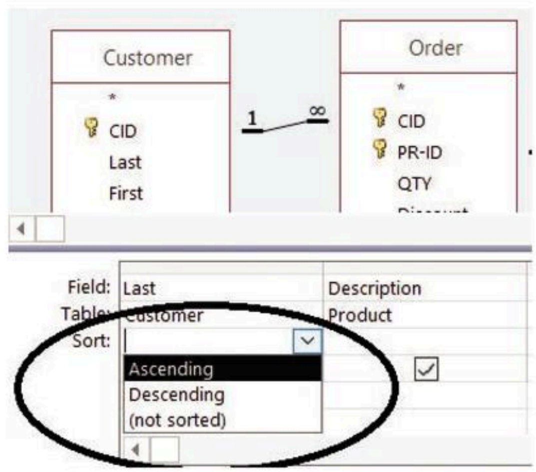


Fig 8.28 Design view showing how the last names of the customers can be sorted in ascending order

Figure 8.29 shows how the Sort and Filter menu option in Datasheet view is used to sort the data.

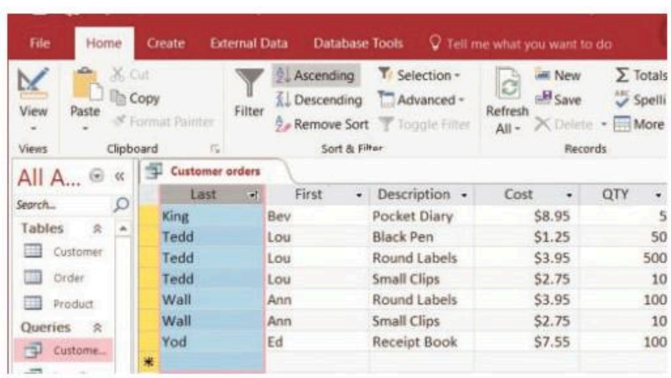


Fig 8.29 Using the Sort and Filter menu option in Datasheet view to sort the data

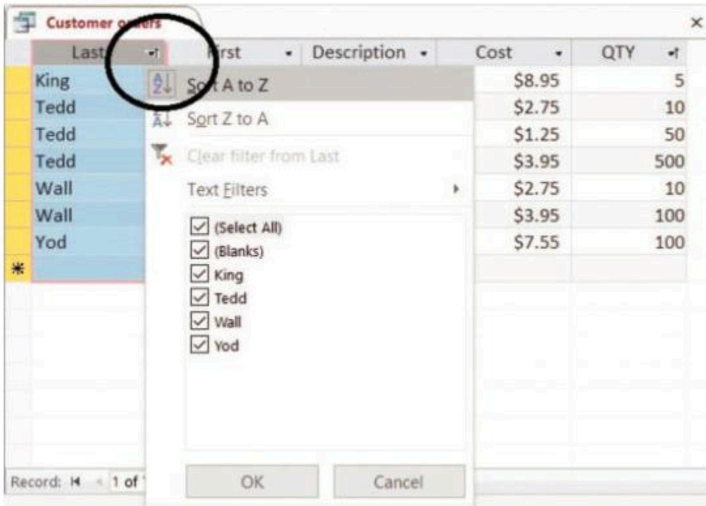


Fig 8.30 Using the sort option to the right of the field name to order the data

Figure 8.30 uses the Sort option in the field names to order the data.

All these methods will give the following results.

Last	First	Description	Cost	QTY
King	Bev	Pocket Diary	$8.95	5
Tedd	Lou	Small Clips	$2.75	10
Tedd	Lou	Round Labels	$3.95	500
Tedd	Lou	Black Pen	$1.25	50
Wall	Ann	Small Clips	$2.75	10
Wall	Ann	Round Labels	$3.95	100
Yod	Ed	Receipt Book	$7.55	100

Questions

1 Select the most suitable options that describe the sorting of data as A to Z:

- **i** ascending
- **ii** descending
- **iii** top to bottom
- **iv** bottom to top.

Use the query template shown in Figure 8.31 to answer questions 2 and 3:

2 You wish to list the names of the products that cost under $3.00.

- **a** Write one or more tables that would be used in the query.
- **b** List the field names that would be used in the query.
- **c** Write the field name and the criteria for the query.
- **d** How would the criteria change if the query was changed to list the products that cost $3.00 or less?

3 You wish to list the names of the products that are on discount.

- **a** Write one or more tables that would be used in the query.
- **b** List the field names that would be used in the query.
- **c** Write the field name and the criteria for the query.

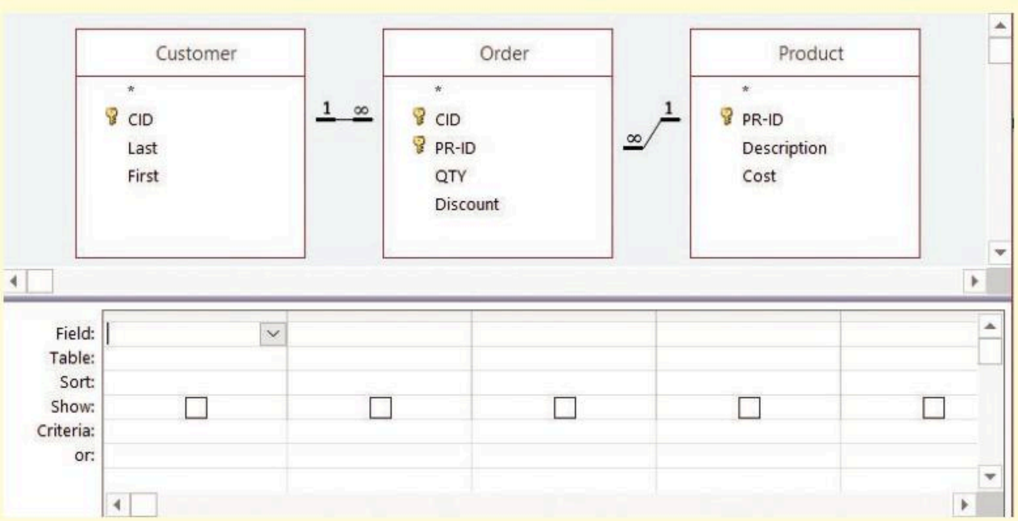


Fig 8.31 Query template

Practical exercises using Microsoft Access

Exercise 11: Searching and sorting

1 Use the Bookshop database to create queries to list:

- **a** the names of the products that cost under $3.00
- **b** the products that cost more than $5.00
- **c** the names of the products that are on discount; sort by the name of the product
- **d** all customers who ordered Black Pens; sort by the customer's last name
- **e** the customers who ordered products costing less than $5 in quantities of more than 100
- **f** the customers who ordered products costing less than $5 OR quantities of more than 100
- **g** all orders except those placed by Customer Lou
- **h** the names of products that begin with 'R'
- **i** the customers whose last name begins with 'Y'.

A calculated field is a 'virtual field' in a query or report. The value in this calculated field is a function of one or more fields from a table or query.

The syntax of a calculated field is always the same:

New field name: [Expression]

Calculated fields with numbers

For example, the syntax for the calculated field called Total Cost is:

Total Cost: [Cost] * [QTY]

where Cost is the cost of the item and QTY is the quantity ordered (Fig 8.32).

Note that:

- There must be a colon after the new field name.
- Only the field names are enclosed in square brackets.
- The field names must be written exactly as they are in the table, otherwise the system may not recognise them.
- The calculated field name (such as Total Cost) should be a meaningful name and can contain spaces and underscores or dashes.

In this case, the expression for this calculated field involves two fields from the Bookshop table (Cost and QTY), and the multiplication operator. The Total Cost field may contain $27.50 as one of the calculated field results.

Mathematical functions

An aggregate query is a special type of query within Access that allows you to group your numerical data to perform specific mathematical functions. Some of these functions are shown in Table 8.6.

Table 8.6 *Aggregate functions*

Group By	matching values in a field are grouped together
Sum	will give a total of all the records in this field for the groupings indicated in the Group By field
Avg	will give the average of all records in the specified fields within each grouping
Min	will return the single lowest value from the group of records
Max	will return the single highest value from all records within the grouping
Count	counts the number of entries within the designated field

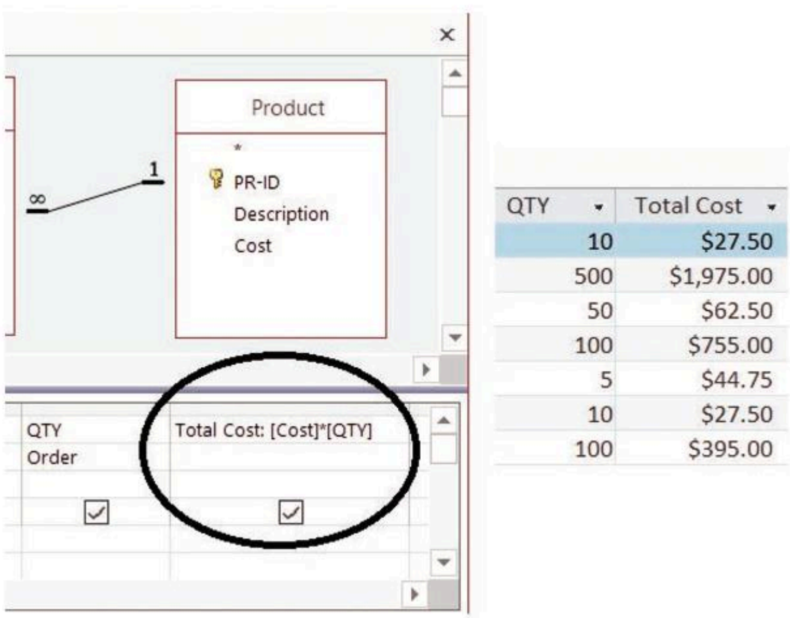


Fig 8.32 Creating a calculated field for the total cost of a product

To use an aggregate function, you must first create a query either by activating the wizard or using Design view. Add fields which can be used in a calculation. Next click on the Totals icon Σ. This causes an extra row in the criteria area to be added. A suitable aggregate function from the Group By list can be selected and then the results are viewed.

For example, to find the total cost for each customer, after adding the cost field to the query, click on the Totals icon (Fig 8.33). Then in the Cost field select the SUM function from the Group By list (Fig 8.34). The total cost of each customer's order is shown in the result. Save the query as Costs of Orders.

You can choose to sum the items, giving an overall total of the items sold (Fig 8.34). Save the query as 'Sales' and click on the Datasheet view icon to see the results. You can click on the Design view icon again to perform other functions shown in Table 8.6.

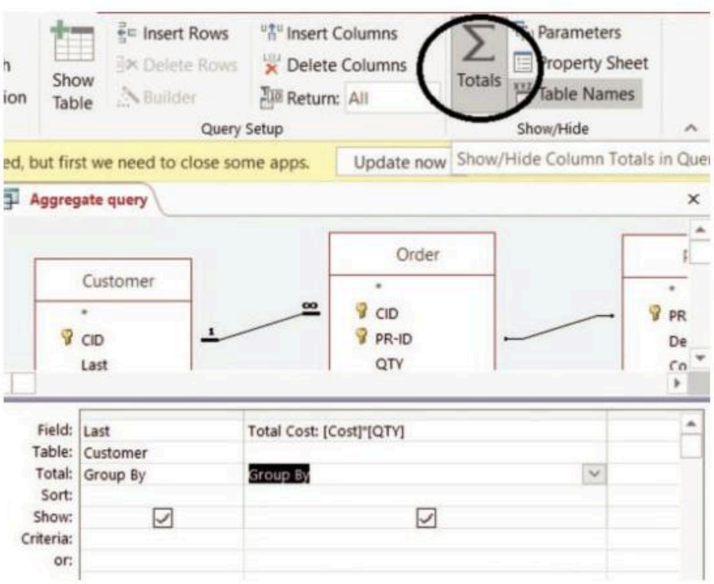


Fig 8.33 The Totals icon is used to create aggregate queries. The icon is found in the Design view of the query menu

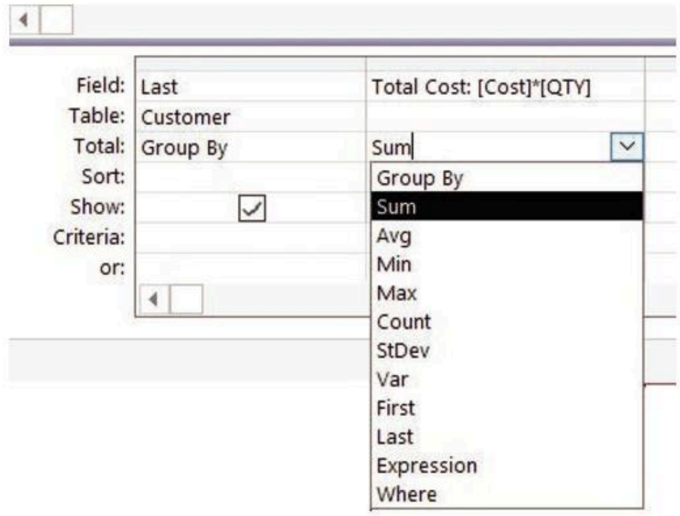


Fig 8.34 Clicking on the Totals icon in the query produces an extra line 'Total' in the design grid, where the list of aggregate functions is shown

Results of using the SUM aggregate function:

Last	Total Cost
King	$44.75
Tedd	$2,065.00
Wall	$422.50
Yod	$755.00

Calculated fields with text

Suppose you wish to produce a field containing the product ID and its description. The syntax for the calculated field called Desc is:

Desc: [PR-ID] & [Description]

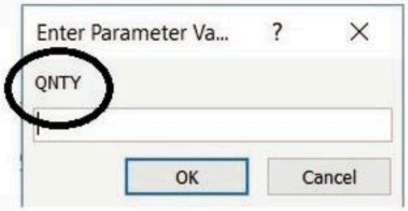
In this case, the expression involves two fields from the Product table (PR-ID and Description) and the ampersand (&) operator. So, the Desc field may contain 'P3639Round Labels' as one of the calculated field results.

Instead of having PR-ID and Description run together in the new Desc field, you may prefer to have a space separating the two parts. The syntax can therefore be modified to:

Desc: [PR-ID] & " " & [Description] to produce 'P3639 Round Labels'.

Errors in queries

Sometimes, after you have created a calculated field and run the query, you see a dialogue box asking you to 'Enter parameter value'. This occurs when you spell a field name incorrectly and your database program cannot find the misspelled field name (Fig 8.35). To solve the problem, simply correct the spelling mistake in the field name.



Access could not find the field name QNTY. The correct field name is QTY

Fig 8.35 A Spelling error in a calculated field

Questions

1 Given the field names Firstname, Lastname, Description and Cost, create calculated fields to produce the following:
   - **a** Join the Firstname and Lastname fields so that the result is similar to 'Jane Smith'.
   - **b** Join the Firstname and Lastname fields so that the result is similar to 'Smith, Jane'.
   - **c** Join the Description and Cost fields to produce output similar to 'Black pens cost $1.25'.

2 What is the typical cause of an error in a query?

3 Using the table called Bookshop, write calculations to:
   - **a** find the total cost of each product ordered where Total cost = Quantity × Cost
   - **b** calculate how much discount is deducted if there is 10% discount on the cost of the product
   - **c** find the mark-up on each product where New Cost = cost × 1.10.

4 State the function that will produce:
   - **a** the total cost of all orders
   - **b** the product that is the least expensive
   - **c** the product that is the most expensive
   - **d** the total number of products.

Practical exercises using Microsoft Access

Exercise 12: Calculated fields

1 Use the Bookshop database to create the queries to:
   - **a** calculate how much discount is deducted if there is 10% discount on the cost of the product
   - **b** find the mark-up on each product where New Cost = cost × 1.10
   - **c** find the name of the product that is the least expensive
   - **d** identify the most expensive product
   - **e** calculate the total number of products.

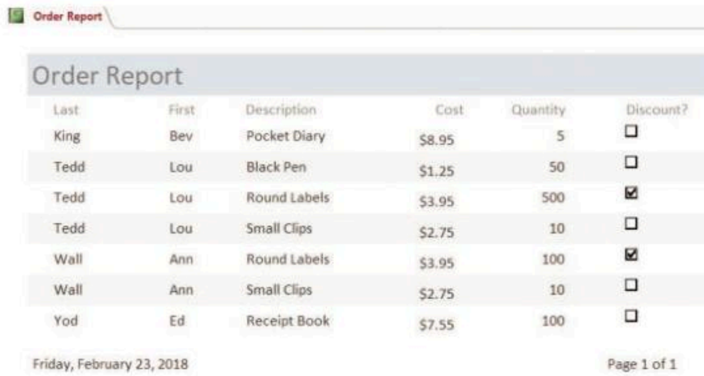
Exercise 13: Creating an aggregate query

1 Open the Bookshop database.
2 To produce a calculated query, create a query, either by activating the wizard or using Design view.
3 Add the Last name field in the Customer table, Cost field in the Product table and QTY field in the Order table to the query.
4 Click on the Datasheet view icon to see the results. Then in Design view, in a new field type Total Cost:[Cost]*[QTY]
5 Remove the checkmarks in the rows for Cost and QTY that show those columns of data, so that only Last and the Total Cost are shown.
6 Click on the Datasheet view icon to see the results.
7 Select the Totals icon on the Menu bar. Your query now has an extra line 'Total' in the design grid, while the Group By option is now shown under each field in the query.
8 Change the Group By in the Cost and QTY columns to Expression, and change the Group By in the Total Cost column to SUM.
9 Click on the Datasheet view icon to see the results.
10 Save the query as 'Total Orders'.

A query simply selects particular records from the database. Often you may want to display only some fields from the records that are found or display the records in a particular order. A report is an effective way to present your data in a printed format, because you have control over the size and appearance of the data and headings. Fields in the report can be grouped with different kinds of subtotals including sum, minimum, maximum and average.

Typically, a report will let you specify these things:

- which fields to display
- where to display the fields
- the order in which records should be displayed
- how records should be grouped together
- what statistics you want the database to calculate from the records (for example, number of records, average values of fields).



Order Report

Order Report

Last	First	Description	Cost	Quantity	Discount?
King	Bev	Pocket Diary	$8.95	5	☐
Tedd	Lou	Black Pen	$1.25	50	☐
Tedd	Lou	Round Labels	$3.95	500	☑
Tedd	Lou	Small Clips	$2.75	10	☐
Wall	Ann	Round Labels	$3.95	100	☑
Wall	Ann	Small Clips	$2.75	10	☐
Yod	Ed	Receipt Book	$7.55	100	☐

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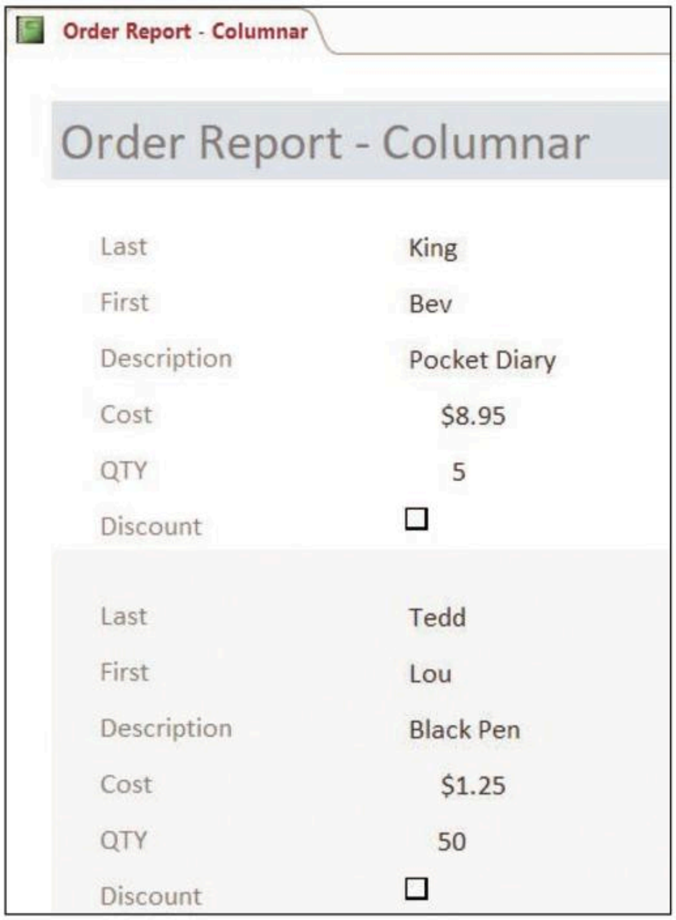
Fig 8.36 Example of a tabular report

Standard report formats

Standard reports can be either:

- tabular (set out as a table) (Fig 8.36) or
- columnar (set out as a form) (Fig 8.37).

When a *tabular report* is printed, multiple records are printed on each page. Each record takes up one line in a table. The names of the fields are printed at the top of the table. Options provided in the report will let you determine in what order the names are printed on the report. Grouping could be used to divide the field names on the report into groups. For example, the types of items could be grouped by the supplier. Most databases will print each group on a separate page. *Columnar reports* print each record on a separate form. Usually each form is printed on a different page. Columnar reports are often used for printing items such as tickets.



Order Report - Columnar

Order Report - Columnar

Last King
First Bev
Description Pocket Diary
Cost $8.95
QTY 5
Discount ☐

Last Tedd
First Lou
Description Black Pen
Cost $1.25
QTY 50
Discount ☐

Fig 8.37 Example of a columnar report

Creating a report

The fastest and easiest way to create a simple report using a database such as Microsoft Access is with a wizard which automatically creates a report by arranging all of the fields from a table or query into a neatly formatted report.

To create a report:

1 Activate the Report Wizard on the Access menu.
2 Select the table or query from the Tables/Queries drop-down menu (Fig 8.38).

Fig 8.38 Select the table or query from the Tables/Queries drop-down menu

3 Select the fields that should be displayed in the report by transferring them from the Available Fields window in the left pane to the Selected Fields window. Use the single right arrow button > to move fields one at a time or the double arrow button >> to move all the fields at once.
4 Click the Next button to move to the next screen.
5 Depending on the number of tables in your database, you may have options on how to view your data. You may not always see this option.
6 Decide if you would like to group your fields (Fig 8.39). Click the right arrow button > to add those fields to be grouped. Use the Priority buttons to change the order of the grouped fields if more than one field is selected.
7 Click Next to continue.

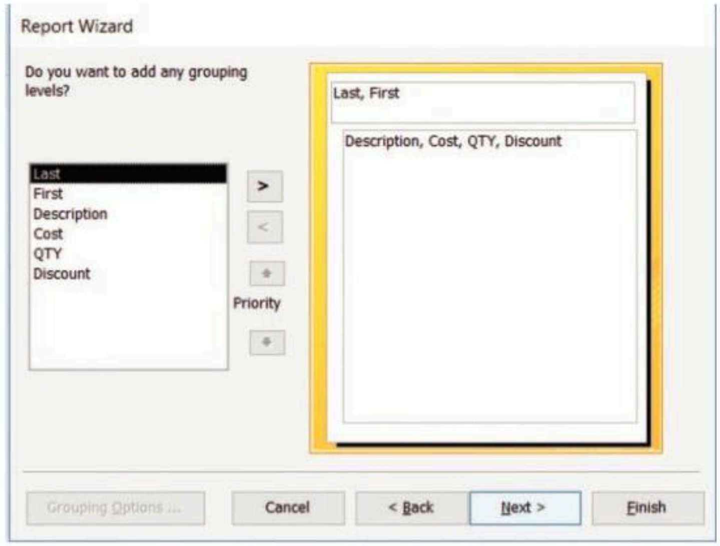


Fig 8.39 Decide if you wish to group any fields

8 Decide if you wish to sort any fields (Fig 8.40). If the records should be sorted, identify a sort order here. Select the Last field to be sorted by and click to choose from ascending or descending order. Click Next to continue.

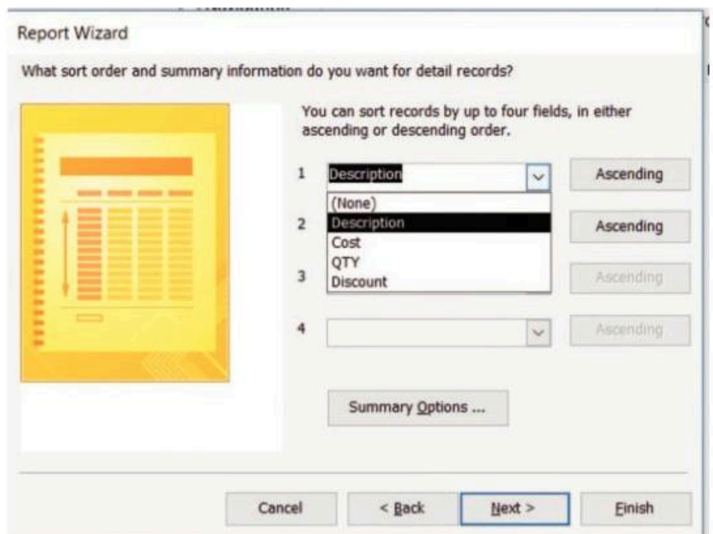


Fig 8.40 Decide if you wish to sort any fields

9 If there are fields in the report that contain numeric values, you can choose whether to apply certain summary functions such as sum, average, max or min to the report. For example, you may want to sum the quantities of items ordered (Fig 8.41). Click Next to continue.

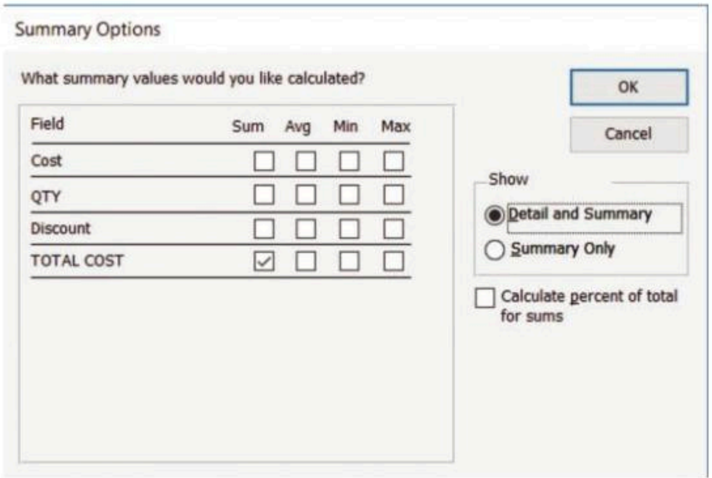


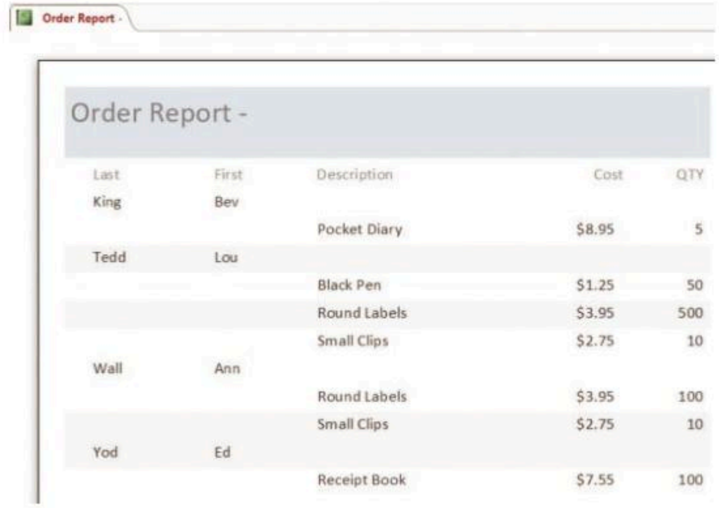
Fig 8.41 Summary options can be added to the report

10 Select the layout and the paper orientation you want and click Next if there are any other options regarding the orientation or the style you desire.

11 On the final screen, name the report (Fig 8.42) and select to open it typically in Print Preview mode. Click the Finish button to create the report. You may wish to preview the report before you print it.

Fig 8.42 Finally, give your report a title

12 If the fields are too wide you can adjust the final look of the report (Fig 8.43). Close Print preview mode and choose Design view or Layout view to adjust the width of the fields.



Order Report -

Last	First	Description	Cost	QTY
King	Bev			
		Pocket Diary	$8.95	5
Tedd	Lou			
		Black Pen	$1.25	50
		Round Labels	$3.95	500
		Small Clips	$2.75	10
Wall	Ann			
		Round Labels	$3.95	100
		Small Clips	$2.75	10
Yod	Ed			
		Receipt Book	$7.55	100

Fig 8.43 You can adjust the report if the fields are too wide

Order Report - February

First	Last	Description	Cost	Quantity	Discount	TOTAL COST
Ann	Wall	Round Label	$3.95	100	☑	$395.00
		Small Clips	$2.75	10	☐	$27.50
Bev	King	Pocket Diary	$8.95	5	☐	$44.75
Ed	Yod	Receipt Bool	$7.55	100	☐	$755.00
Lou	Tedd	Black Pen	$1.25	50	☐	$62.50
		Round Label	$3.95	500	☑	$1,975.00
		Small Clips	$2.75	10	☐	$27.50

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Fig 8.44 Order report after fields are adjusted

Orders Report

First	Last	Description	Cost	QTY	TOTAL COST	Discount
Ann	Wall	Round Label	$3.95	100	$395.00	☑
		Small Clips	$2.75	10	$27.50	☐
Summary for 'Last' = Wall (2 detail records)						
				Sum	$422.50	
Bev	King	Pocket Diary	$8.95	5	$44.75	☐
Summary for 'Last' = King (1 detail record)						
				Sum	$44.75	
Ed	Yod	Receipt Bool	$7.55	100	$755.00	☐
Summary for 'Last' = Yod (1 detail record)						
				Sum	$755.00	
Lou	Tedd	Black Pen	$1.25	50	$62.50	☐
		Round Label	$3.95	500	$1,975.00	☑
		Small Clips	$2.75	10	$27.50	☐
Summary for 'Last' = Tedd (3 detail records)						
				Sum	$2,065.00	

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Fig 8.45 Order report with summary fields included

Printing the report

Once your report is ready to be distributed, it can be printed or exported to other applications. You can activate the print option to print your report to a printer or export it to a format that is compatible with a word processor. In recent versions of Microsoft Access, you are able to export your report to formats such as Excel, PDF, rich text, HTML or as an email attachment via Microsoft Outlook. Rich text is a common format for exporting a report to a word processing document such as Microsoft Word (Fig 8.46).

To export a report to rich text format:

1 Select the report that you wish to export.
2 Double-click to open the report.
3 Use the View icon and select Print Preview.
4 Select rich text option to export the report.
5 You will be prompted to confirm the name and location of the exported report.
6 Select the option to open the destination file after the export operation has been completed. This is useful to view the exported report.

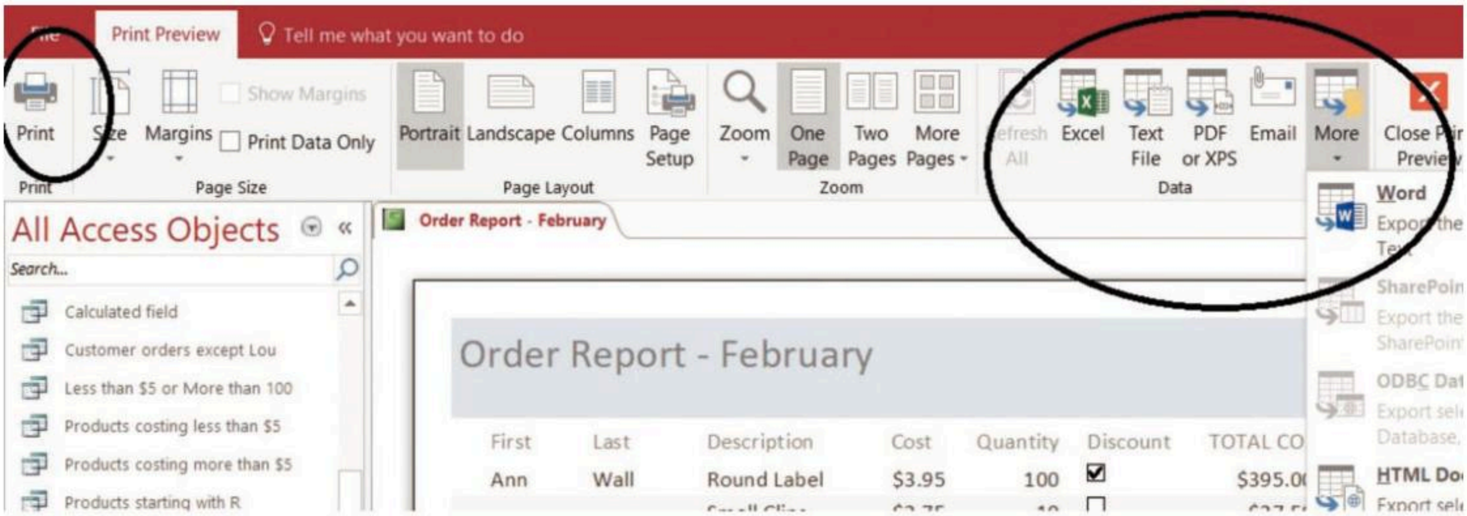


Fig 8.46 Reports can be printed or exported to other applications

Questions

Consider the report shown in Figure 8.44.

1 Explain whether the report is formatted as tabular or columnar. Identify:
   - a the data type of each field
   - b the grouping field
   - c the sort field
   - d the calculated field
   - e the title of the report
   - f how many products Lou Tedd ordered.

2 Consider the following report. Identify:

a the data type of each field
b the grouping field
c the sort field
d the calculated field
e the title of the report
f the summary function used in the report.

Payroll for September				
Department	**Last Name**	**First Name**	**Days Worked**	**Fees**
Marketing				
	Betham	Milo	28	$4,200
	Janis	Yannick	31	$3,720
	Pimmot	Ross	28	$3,360
	Rithmont	Cath	22	$2,640
Summary for 'Department" (4 detail records)				
			Sum	$13,924
Human Resources				
	Jomes	Mike	28	$3,360
	Steele	Jonat	29	$3,480
	Ummer	Rain	28	$3,360
Summary for Human Resources (3 detail records)				
			Sum	$10,203
			Grand Total	$24,127

Practical exercises using Microsoft Access

Exercise 14: Creating reports

1 Create a report using the Bookshop database.

a Create the reports in Figure 8.36 and 8.37.
b Create the report in Figure 8.43.
c Group the fields by First and Last.
d Sort by Description.
e Use the block layout so that the first and last names are on the same row.
f Give the report the name Order Report.
g View the report.

2 Use the Sports database that you created in Exercise 10 to produce a report. (The data is shown again here.)

TEAM			
AthleteID	**NameOfAthlete**	**Code**	**Gender**
121	Jade Boyce	U13	F
231	Shade Skeete	U13	F
351	Neil Hall	U20	M
142	Figman McJig	O20	M

DIVISION	
Code	**Category**
U13	Under 13
U20	Under 20
O20	Seniors

a Use the fields Category, NameOfAthlete and Gender.
b Group the report by Category.
c Sort the data by Gender.
d Name the report 'Report on Athletes by Category'.

3 Create another report using the Sports database.

a Group by Gender.
b Sort by Category.
c Name the report 'Report on Athletes by gender'.

You can import data from another database file, or from another application into an existing database. For example, schools could each send a database file to the national sports association for the upcoming sports meet. This data can then be imported into the association's database so that the categories of sports and age groups can be organised without having to re-enter the data. It is also possible to merge (combine) two or more database files.

Importing to a database

Here are two hints when importing data to Access:

- Name your fields using one-word names. Access allows you to use typical field names, but it may give you problems if you have field names with more than one word, especially if there are spaces between them. Therefore, it is best to use underscore (_) or simply keep the words in the field name together.
- If possible, export or import a small test amount of the data.

If the table has lots of records but not too many fields, try importing the first 10 and last 10 records, then write some queries. This will save time in the long run. If it has lots of fields, but not too many records, then go ahead and import the full table.

To import data to a table, select the table. Then right-click on the table and select Import. There are many options to choose which application you wish to use to import the data. The most common methods of importing data are from another Microsoft Access database, an Excel spreadsheet or a text file.

Exporting from a database

One way to export data is using the copy and paste method. Open the database containing a table or query that is to be copied (exported) to another database. Find the table or query in the Database window and highlight it. Then select all the data (Fig 8.47) and click on the Copy icon. Open an Excel sheet or Word document and paste the table or query in the required location.

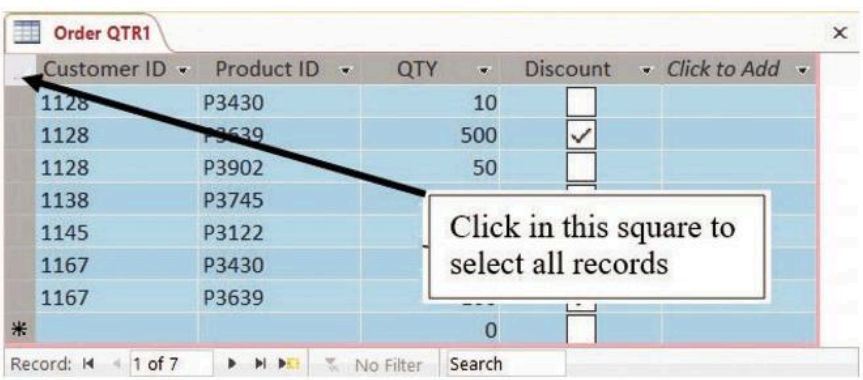


Fig 8.47 Selecting all data in a table or query

Questions

1 What is the difference between exporting and importing data?

2 What is another method of exporting data from Access to a Word document?

Practical exercises using Microsoft Access

Exercise 15: Importing an Excel file

1 Open Excel and create the following worksheet starting at cell A1. Save it as DATA.

	A	B	C
1	**StudentID**	**Name**	**Age**
2	1123	Angelo	16
3	2212	Shanico	15
4	3346	Franco	17
5	3358	Vanessa	16

Generally, spreadsheet files should be formatted as follows:

- **a** The top row should contain only row headings or field names.
- **b** Either remove any cells that you do not wish to import or copy the ones that you do to another worksheet.
- **c** Save the file.
- **d** Remember the name of the worksheet and the file and its location.

2 Open Access.

- **a** Either create a new database, or open an existing one, depending on where you wish to place the Excel file. For this example, create a database called TEST.
- **b** On the menu, activate the tab with the External Data option.
- **c** Look for the icon to import data and select Excel or the Excel data type depending on your version of Microsoft Access.
- **d** If the name of the file you wish to import is not visible in the Import window, browse to the folder where it is located. In this exercise, browse for the spreadsheet file named DATA and select it.
- **e** You can choose to import it to a new table, or append it to an existing table
- **f** Select the worksheet from the pop-up window or, if you have named a range, select it.
- **g** Click Next.
- **h** If you get a message that the first row contains some data that cannot be used for valid field names, click OK to let the wizard assign valid field names. You can clean this up later.
- **i** If the box 'First Row Contains Headings' is not checked, tick it.
- **j** Click Next.
- **k** Select 'In a new table' and click Next.
- **l** You can change the name and data type of a field while importing:
  - **i** Select the field whose name you wish to change by clicking anywhere in that column
  - **ii** Click Next.
  - **iii** Choose the field name which will be the primary key and click Next. In this example choose StudentID.
  - **iv** Enter the name 'STUDENTS' for this table and click Finish.
- **m** You will receive a message that Access has finished importing the file.
- **n** Click OK.

3 If the Excel file was not formatted properly, and you get an error message, return to Excel and prepare the file as in step 1.

4 If there were blank lines in the Excel file you may wish to delete these 'records'.

Before you create a database you need to think about the most efficient and convenient way to store the information so that it can be retrieved in the format you want. Although a database can be modified after it has been created, it is much easier to get it right to begin with. Points to consider are:

- The names of your database, tables, forms, queries and reports. Like any other names, they should reflect the information they contain.
- The way in which you wish to store the information. For example, names of people should have at least three fields – title, initials and last name – to give maximum flexibility in using the data; similarly, addresses normally require at least six fields, for building/house name, street, town, county, postcode and country (if appropriate).
- The number of tables and fields you require and how the tables might be linked. Try to think of all the information you might want to get out of the database.
- The names of the fields. These may be up to 64 characters in length, but about 15 is a more normal size. You can use A–Z and 0–9 in your field names but are advised to avoid using spaces and symbols. Use underscores if you wish to separate field names. Try to choose sensible names which are self-explanatory.
- The size of the fields. For example, you might choose a field size of 8 for a Text field that stores eight-character codes. That means you cannot accidentally enter more than eight characters in the field.
- The type of data to be entered. You need to be aware of text or specific numbers that will not be used in calculations, as opposed to numbers that will be used in calculations, dates, currency, etc. This can help you to decide what data or field types to use for each field. You may want to consider primary key fields as Text fields if they do not involve calculations.
- The design of forms. If the information is being taken from, for example, a paper form, it is more efficient to design your online form so that the information is entered in the same order as it is read from the paper form.

When you have set up the structure of your database, you should:

- put some information into the database so that it can be tested
- run the queries and reports to test if the database is operating correctly.

Common design problems

There are several common pitfalls to keep in mind as you design your database. These problems can cause your data to be harder to use, maintain and retrieve. The following are signs that you should re-evaluate your database design:

- You have one table with a large number of fields that do not all relate to the same subject. For example, one table might contain fields with information about your customers as well as fields that contain sales information. Each table should contain data about only one subject.
- You have fields that are intentionally left blank in many records because they are not applicable to those records. This usually means that the fields belong in another table.
- You have a large number of tables, many of which contain the same fields. For example, you have separate tables for January sales and February sales, or for local customers and remote customers, in which you store the same type of information. Try consolidating all the information about a single subject in one table. You may also need to add an extra field, for example to identify the sales date.

Questions

1. Why it is advisable to design a database before you start to create it using the computer?
2. Give four design suggestions that relate to tables.
3. Why should you enter sample data into your database initially?
4. Explain one common design problem.

Multiple choice questions

1 When a customer makes an online hotel booking, the database is updated by using a:

a table
b form
c query
d report.

2 When making a payment online, the database is updated in:

a batch mode
b real-time
c HTML
d e-commerce.

3 The database view that presents data in a format that is similar to a spreadsheet is:

a datasheet
b design
c print
d report.

4 Which of the following defines what kind of data is used in a database?

a type
b length
c name
d description.

5 In databases and tables the rows refer to __________ and columns refer to __________.

a data types, records
b field names, records
c records, data types
d records, field names.

6 A database form can do all of the following ways, *except*:

a add
b modify
c merge
d delete.

7 Datasheet view allows you to enter __________ into your database table.

a fields
b raw data
c data types
d descriptions.

8 The correct database syntax for a field called Price which calculates 10% of the cost of an item in a field named Cost is:

a Price: [Cost] × 10%
b Price: [Cost]*.10
c Price: [Cost] × [10%]
d Price: Cost*.10

9 Data can be imported to a database using any of the following, *except*:

a text delimited
b tab-separated text
c comma-separated values (CSV)
d Portable Document Format (PDF).

10 A primary key field that appears in one table but is also located in another is called a(n):

a foreign key
b alternate key
c candidate key
d secondary key.

Short answer questions

11 BGI is a training company with branches in the Caribbean. The company needs to update its schedule of workshops and assign trainers.

a For each of the following tasks, describe one application that would be most suitable to use:

i A list of employees who have completed recent workshops along with a schedule of upcoming workshops are sent to the Human Resource Director of each business.
ii Payments for travel and hotel accommodation are calculated for monthly salary payments.

- **iii** Flyers are produced to advertise new workshops.
- **iv** Electronic payments can be made via the company's online payment screen.
- **v** A list is needed to store data on all participants in each country along with workshops that were completed, ongoing or not completed.

b Identify the computer-related professional who would be responsible for managing databases.

c The trainers use a special program that was designed for participants to access course-related materials during the workshops. Suggest the general type of application package that could be used and explain whether it is off-the-shelf, customised or custom-written.

12 A database was used to store requests for training and assigning trainers. The three tables in Figures 8.48, 8.49 and 8.50 show a sample of the data.

TABLE: COMPANY			
CO_ID	**Country**	**Company**	**NumtoTrain**
6985	Guyana	Rumaba	56
6987	Trinidad	Mariob	45
7295	Jamaica	Courtstreet	87
7324	Barbados	EveryInc	42
7361	Antigua	St. Micks	50
7455	Belize	Maggow	68

Fig 8.48

TABLE: TRAINER			
TR_ID	**FName**	**LName**	**Subject**
G10	Georgia	Inns	Management
K21	Keith	Kettis	Housekeeping
V31	Van	Hall	Accounting

Fig 8.49

TABLE: SCHEDULE			
TR_ID	**COID**	**Arrival**	**Departure**
G10	6985	05/09/2019	05/12/2019
V31	6985	05/09/2019	05/12/2019
V31	6985	05/16/2019	05/20/2019
K21	6985	05/16/2019	05/20/2019
V31	7295	05/25/2019	05/31/2019
G10	7324	06/15/2019	06/28/2019
K21	7361	07/13/2019	07/16/2019
G10	7361	07/13/2019	07/16/2019
V31	7455	07/21/2019	07/29/2019
G10	7455	07/21/2019	07/29/2019

Fig 8.50

a State:
- **i** the number of records in the Company table.
- **ii** the data type of the TR_ID field.

b Copy the diagram in Figure 8.51 and use it to draw the links that create relationships between pairs of tables.

Fig 8.51

c Consider the form in figure 8.52, which was created using the database.

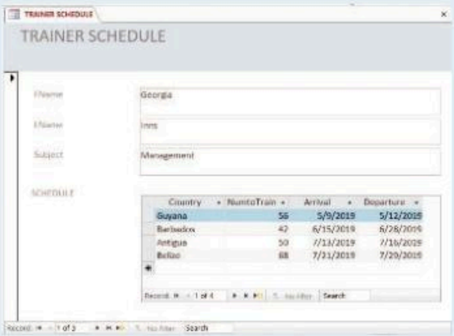


Fig 8.52

- **i** Identify the names of the two sections of the form.
- **ii** State the total number of trainers, including Georgia, as shown in the form.
- **iii** State the name of the function that calculates the total number of participants Georgia would be training.
- **iv** Write the formula (named DAYS) that will calculate the number of days that Georgia would be in Belize.

d A letter is sent to companies with training scheduled in Antigua and Belize.

- **i** Identify the workshops that will be offered.
- **ii** Which word processing feature is most appropriate to send letters to those companies?
- **iii** Indicate the name of the table and what other fields would be required for the letters.

e State the fields and criteria for each of the following questions:

- **i** What are the names of the workshops that were requested by Maggow?
- **ii** Who are the trainers scheduled to travel before 5/15/2019?

f Identify the database feature that performs the calculation in part **e**.

g Determine the results of the questions in part **e**.

CHAPTER 9

PROBLEM SOLVING AND PROGRAM DESIGN

9.1 Introduction to problem solving

Software is the name given to computer programs that tell (instruct) the hardware how to work. Software therefore includes computer programs that create system and application software. Each program exists because a problem first existed, and a solution was needed to solve that problem.

Solving a problem

You should first develop an **algorithm** to solve the problem. An algorithm is a sequence of *precise* instructions which results in a solution. If your algorithm is vague and has conflicting logic, you will not get the correct answer.

Problem solving is usually broken into two phases.

Algorithm phase

In the first phase, there are five general steps:

1. Clearly define the problem that you want to solve.
2. Propose solutions and evaluate each one.
3. Select the most reasonable solution.
4. Design an algorithm that is precise and well thought out to solve the problem.
5. Test your algorithm. You must be sure your algorithm works correctly before you can write a program for it.

Implementation phase

In this phase, there are three main steps:

1. Translate your algorithm using a programming language such as BASIC, Pascal, C or VisualBasic.
2. Execute the program code.
3. Maintain the program.

For now, let's focus on the algorithm phase.

Defining the problem

When you first analyse a problem, you should specify your objectives, that is, what the program is meant to do. The following four steps are used to organise and summarise a program's objectives:

1. Specify the output: What kind of output are you expecting from this program? Will this output be one or more numbers, text, numbers *and* text, or even a graphic? Is this output in readable form or is it for input to another program? Will it be displayed on a monitor as soft copy, printed or stored in a file?
2. Specify the input: If you know what the output is, you can specify what values are needed for the input. Data can be captured by an input device such as a keyboard, transferred from a secondary storage device or even entered via voice recognition.
3. Specify the processing: What processing should be done on the input to get the necessary output? For example, what calculations are needed? Is the processing grouped as a batch or completed in real time as the data is captured?

Most programs also:

4. Specify the storage: Determine how the data and even the information or results will be stored temporarily or for future use.

Input–processing–output (IPO) charts

IPO charts are used to identify the:

- inputs: the information you need to solve the problem
- processing: the steps needed to convert the input data to the desired outputs
- outputs: the goal of the problem solution.

An IPO chart is not actually a chart, but a table with three columns. Each column represents three components: input, output and processing. The storage component is not usually documented in the chart.

Example 1

You are given a problem of finding the sum of three numbers. What is the goal or output? What input information do you have?

The output or goal is a number which is the sum of the three numbers. The input is made up of the values of the three numbers. What steps are needed to convert the input(s) into the goal(s) or output? The processing requires:

- the input of the three numbers
- adding the three numbers together and saving the result as a single number
- the output of the sum of the numbers.

Notice that the processing column is written in English. The completed IPO chart is shown below.

Input	Processing	Output
number1 number2 number3	Add the three numbers together	Result of the addition

You can follow an IPO chart by reading each column from left to right. For example, the input column indicates that you input three values. In the processing column you add the values that were input. The third column outputs the result of the addition.

Example 2

You are given the problem of finding the average temperature by using maximum and minimum temperature readings. You then calculate and output the average temperature:

(max temp + min temp) ÷ 2

The completed IPO chart is shown below.

Input	Processing	Output
max_temp min_temp	Calculate (max_temp + min_temp) / 2	average_temp

Example 3

Read a number, add 10% and output the result.

Input	Processing	Output
number	result = number + (number * 0.10) OR result = number * 1.10	result

Example 4

Input the regular price of an item; calculate the discount amount at 20% of the regular price and also the item's discounted price. Output the discount amount and the discounted price.

Input	Processing	Output
regular_price	discount amount = 0.20 * regular price discount price = regular price – discount amount	discount amount discount price

Questions

1 Explain the two major phases in problem solving.

2 What do the letters I, P and O refer to in an IPO chart?

3 Explain the purpose of an IPO chart.

4 Show the correct order when solving a problem. The steps are:

 i select solution
 ii design algorithm
 iii define problem
 iv test algorithm
 v propose solutions

To help the simplification and development of the programming problem, algorithms can be created as pseudocode or flowcharts.

An algorithm is a set of step-by-step instructions required to obtain the solution to a problem. It must have a set of rules, be explicit and have a clear stopping point. It is really used to expand the 'processing' part of the IPO chart using diagrams for **flowcharts** or English-type statements for pseudocode. The algorithm should start with a title and end with the keyword END. Developing a program can be a major undertaking, so good algorithm design is very important. It is not always possible to satisfy all the requirements of a good algorithm completely at the same time. Some problems may be complex and hence require complex solutions. However, there are some general goals in designing algorithms. A good algorithm should be:

- *correct:* it should accept all inputs (even invalid inputs!) and output a correct answer or meaningful response or message
- *simple:* each step of the algorithm should perform one logical step in solving the problem
- *clear:* the algorithm should be easy to read and understand
- *precise:* the algorithm should present the solution steps precisely and concisely without referring to low-level (program code) details
- *easy to implement:* the algorithm should be relatively easy to translate into a programming language
- *efficient:* the algorithm should enable the program code to produce results quickly, depending on the problem size, and not waste any memory or time.

Now that you have been introduced to algorithms, you should become familiar with some terminology. These terms apply to both pseudocode and flowcharts.

Variables and constants

Let's explain how data is usually stored when it is input. A variable or constant is an area or space in memory that holds data that a program might use or manipulate. Both could contain text or numerical values.

A constant is a type of variable where the values do not change for that algorithm. Examples of constant values are 3.14 for pi (π), 0.175 for value-added tax (VAT) or 2002 for a year of birth.

The values in a variable can change throughout the algorithm as data is processed. Examples of variable names are *number* and *total*. Each **variable** is given a name so that you can assign values such as numbers or text to them and refer to them later to read the values. Variables typically store values of a given type. Some types of data are shown in Table 9.1.

Table 9.1 *Basic data types*

Data type	Description	Examples
Integer	Integer or 'whole' numbers, positive or negative	63, –12, 0
Real	Numbers including fractional numbers, positive or negative	12.63, 0.5, –8.0
Character	A single character such as a letter of the alphabet or punctuation, as shown on a keyboard	'G', 'b', '*'
String	A collection of characters such as a word, phrase or sentence	"A+" or "Good Job!"
Boolean	Can contain only one of two values	TRUE or FALSE; YES or NO; MALE or NOT MALE

You should use meaningful variable names in your programs so that if you or someone else needs to review the logic of the data being processed, then the variables will be easy to remember and understand.

Statements and keywords

A **statement** is a description of the processing that can include an action or condition. Instructions within the statement are called **keywords**. Examples of keywords are INPUT, READ, OUTPUT, DISPLAY, PRINT or WRITE.

Conditional statements

Conditional statements allow decisions to be made in a program. This includes deciding which statements are to be executed (carried out). For example, you might want a set of statements to execute only if certain conditions are met.

Loops

Loops are useful for repeating parts of a program. That is, they will repeatedly execute a section of program until the end condition is satisfied. In order to exit from a **loop**, you must have a method for checking to see if you have completed the task. Once a loop terminates, control is returned to the first statement after the block of statements in the loop.

Subroutines

For big programs, it is easier to work on small sections by separating the algorithm into individual sections. These sections are known as 'subroutines', 'functions', 'modules' or 'procedures'. A **subroutine** is a named section of a program that can be repeatedly called on to perform a given set of instructions by other parts of the program. Sometimes it returns information to another part of the program, such as accepting a number between 1 and 5 and then returning the corresponding day of the week. Other subroutines might carry out instructions, such as printing the headings of an invoice.

Using subroutines saves writing the same code several times in the program. This method of focusing on the program's main goal, and then separating the program into manageable components is called 'divide and conquer' or top-down design. The individual subroutines can even be tested in isolation to check that they correctly perform their function.

Questions

1. State whether the following statements are true or false:
   - **a** An algorithm can be written as pseudocode.
   - **b** An example of pseudocode is a flowchart.
   - **c** Flowcharts use English-type sentences.
   - **d** Flowcharts use specific symbols.
   - **e** A flowchart can be developed into an algorithm.
2. Explain the purpose of using a variable.
3. Explain the difference between a variable and a constant.
4. State the most suitable data type for each of the following:
   - **a** the current year
   - **b** someone's height
   - **c** a mobile phone number
   - **d** is it day or night?
   - **e** your blood type.
5. For each of the descriptions in question 4, suggest a suitable variable name to store the data.

Pseudocode is not programming code, but uses English-type words and phrases that are clear enough to be easily converted into programming code. It uses the same statements, keywords, variables, conditional statements and loops described in the previous section to create the instructions for a solution to a programming problem. Pseudocode can also be developed from an IPO chart to specify what data is input and processed into information.

Let's first review the IPO chart that finds the sum of three numbers.

Input	Processing	Output
number1 number2 number3	Add the three numbers together	The result of the addition

Note that the variables number1, number2 and number3 will store the first, second and third numbers that are input.

The processing column involves short statements explaining how the data is managed. Here, the values that were input into the variables number1, number2 and number3 are added. The third column indicates that the result of the addition is output.

The name of the segment of pseudocode is *Add_three_numbers*. The keywords INPUT and OUTPUT are used to indicate that data is input, usually using an input device such as a keyboard, while the output can be as soft copy to the screen of a monitor. The keyword END or STOP denotes the end of the statements.

The pseudocode in Example 5 is produced from the IPO chart.

Example 5

```
Pseudocode_5a: Add_three_numbers
INPUT number1
INPUT number2
INPUT number3
Add number1 + number2 + number3
OUTPUT result of number1 + number2 +
number3
END of pseudocode
```

If the three variables that contain the three numbers have the same data type (for example, an integer), then the statements to input the values can be placed on one line as shown in the updated pseudocode below.

```
Pseudocode_5b: Add_three_numbers
INPUT number1, number2, number3
Add number1 + number2 + number3
OUTPUT result of number1 + number2 +
number3
END of pseudocode
```

Now that we are familiar with variables, we can also place the result of the calculation in a variable. Let's name this variable *result*.

```
Pseudocode_5c: Add_three_numbers
INPUT number1, number2, number3
result ← number1 + number2 + number3
OUTPUT result
END of pseudocode
```

The new variable *result* on the left side of the statement will contain the answer from the calculation of the numbers from the right side of the statement.

Calculations can include the left arrow (←) or the equals sign (=) to indicate that the result of a calculation is stored in a variable.

Here is yet another set of pseudocode for Example 5 using different keywords to READ in the data and to PRINT the result. The keyword END can also be used on its own to denote the end of the statements.

```
Pseudocode_5d: Add_three_numbers
READ number1, number2, number3
result = number1 + number2 + number3
PRINT result
END
```

Sequential statements

Sequential statements, such as those in Example 5, are executed one after the other from the first statement to the last.

Let's look again at the IPO chart from Example 2, which finds the average temperature from two values.

Input	Processing	Output
max_temp	Calculate	average_temp
min_temp	(max_temp + min_temp) / 2	

The following pseudocode is produced using sequential statements from the information in the IPO chart.

Example 6

Find the average temperature.

```
Pseudocode_6a: Find_average_temp
INPUT max_temp, min_temp
average_temp = (max_temp + min_temp)/2
OUTPUT average_temp
END
```

First, the value for the maximum temperature is input into the variable (*max_temp*), then the value for the minimum temperature is input into the second variable (*min_temp*). The resulting number from the calculation is placed in the variable (*average_temp*). The result stored in *average_temp* is then output.

Conditional branching

Conditional branching is used when there is a choice between two options. Two types of conditional branching are IF–THEN and IF–THEN–ELSE statements.

IF–THEN statements

The IF–THEN statement suggests that one or more statements will only be considered based on a condition or the answer to a question.

IF (the condition is true)
THEN (carry out one or more statement)
ENDIF

Sometimes the keyword ENDIF is used to indicate the end of the IF–THEN statement. Any statement below the ENDIF in the pseudocode is therefore part of the general pseudocode and not specific to the IF–THEN statement.

Let's use an example. You wish to output the total of three test results, but only if the total mark is greater than 50. In this case, we use the IF–THEN statement.

The pseudocode below shows that the three marks are each input into a variable. The marks are added and the sum is stored in a variable named *total*. The IF–THEN statement is then used to check if the total mark is greater than 50. We do not know the value of the three marks that will be input. Therefore, IF the total mark is greater than 50 THEN its value is output. The sequence of statements stops there.

Example 7

Print the sum of three numbers if their total is greater than 50.

```
Pseudocode_7: Add_three_numbers
READ number1, number2, number3
total = number1 + number2 + number3
IF total > 50
THEN PRINT total
ENDIF
END
```

The condition (or question) asked is: is the total mark greater than 50?

If it is, then the condition is true, the mark is indeed greater than 50. The next statement in the sequence indicates to output the total mark. That is, if we used 20, 25 and 10 as the three marks to be input, then the total mark is 20 + 25 + 10 = 55. Since 55 is greater than 50, it is expected that the value 55 will be output.

The IF–THEN statement does not consider if the total mark is less than or even equal to 50, as there are no statements in the pseudocode that instruct that result to be output. If the total mark is less than or equal to 50, the condition will be false, then the next statement (THEN PRINT total) in the sequence is skipped, and the pseudocode reaches the END without printing anything.

The keywords in this example are READ, IF, THEN, PRINT, ENDIF and END. The variables are *number1*, *number2*, *number3* and *total*.

The general format of an IF statement is:

IF (**condition is true**)
THEN **T-statement(s)**
ENDIF

If **condition is true**, execute **T-statement(s)**

IF is a keyword.

Condition is a Boolean expression, which means its value is either TRUE or FALSE.

T-statement(s) are one or more statements that are included only if the result of the condition is TRUE.

ENDIF tells the computer that the IF–THEN statements finish here.

If the condition is FALSE, skip **T-statement(s)** – that is, do not execute them.

Consider the following example to find out if a student is younger than 13 years old. If so, then we want to output the statement "Student is not a teenager". For this, we need to use an IF–THEN statement.

Example 8

First, create an IPO chart.

Input	Processing	Output
age	Check if age < 13	If true then output "Student is not a teenager"

You can write the pseudocode much as it is written in the above sentence.

```
Pseudocode_8a: Is_student_a_teenager
INPUT age
IF age < 13
THEN output "Student is not a teenager"
ENDIF
END
```

Another variation of the pseudocode is to input the student's year of birth and the current year to calculate the age of the student.

```
Pseudocode_8b: Is_student_a_teenager
thisyear = 2019
INPUT birthyear
age = thisyear - birthyear
IF age < 13
THEN OUTPUT "Student is not a teenager"
ENDIF
END
```

Note that *thisyear = 2019* is an example of a constant where the value 2019 is not modified in the algorithm. The variable *birthyear*, however, changes when new data is input.

Example 9

Consider the following example that checks for exam marks of 80 or over:

```
Pseudocode_9a: Exam_results
INPUT mark
IF mark >= 80
THEN OUTPUT "Excellent!"
OUTPUT "Please see your teacher"
ENDIF
END
```

The pseudocode will output the following statements for values stored in the variable *mark*:

Value of mark	Example of mark	Statements output
80 or greater	86	Excellent! Please see your teacher
less than 80	71	Please see your teacher

Notice the use of indentation in the following IF-THEN statement:

```
Pseudocode_9b: Exam_results
INPUT mark
IF mark >= 80
THEN   OUTPUT "Excellent results!"
       OUTPUT "Please see your teacher"
ENDIF
END
```

This suggests that both statements will be output if the condition is true and the variable mark contains a value greater than or equal to 80. Nothing is printed if a value less than 80 is stored in the variable *mark*.

Value of mark	Example of mark	Statements output
80 or greater	86	Excellent results! Please see your teacher
less than 80	71	

IF–THEN–ELSE statement

The IF–THEN–ELSE statement directs the algorithm to one or more statements if the outcome of the condition is valid or true. The algorithm is directed to another set of statements if the outcome of the condition is not valid or false.

IF (the condition is true)
THEN (carry out one or more statements)
ELSE (carry out one or more statements)
ENDIF

Example 10

As an example, suppose you wish to print 'the sum is less than 50' if the sum of three numbers is less than 50, but output their sum if it is greater than 50. This means you have two options: you can either print the comment or print the sum.

Input	Processing	Output
Read number1, number2, number3	Total = number1 + number2 + number3 Check if total > 50	If true, then Output Total If false, then Output 'The sum is less than 50'

In this case, use the IF–THEN–ELSE statement. The pseudocode shows the modification.

```
Pseudocode_10: Add_three_numbers
READ number1, number2, number3
total = number1 + number2 + number3
IF total > 50
THEN PRINT total
ELSE PRINT "The sum is less than 50"
```

The following examples also illustrate the IF–THEN–ELSE statement.

Example 11

```
Pseudocode_11: Is_Millee_a_teen
INPUT thisyear
INPUT birthyear
age = thisyear – birthyear
IF age < 13
THEN OUTPUT "Millee is a teenager"
ELSE OUTPUT "Millee is not a teenager"
ENDIF
END
```

You could also choose to output Millee's age to produce the following:

```
IF age < 13

THEN OUTPUT "Millee is a teen, her age
is", age

ELSE OUTPUT "Millee is not a teen"

ENDIF
```

The general form of an IF–THEN–ELSE statement is:

IF (**condition is true**)
THEN **T-statement(s)**
ELSE **F-statement(s)**
ENDIF

If **condition is true**, execute **T-statement(s)**. Do not execute **F-statement(s)**.

If **condition is false**, execute **F-statement(s)**. Do not execute **T-statement(s)**.

Nested conditions

Nested conditions involve the use of IF–THEN or IF–THEN–ELSE statements, either separately or combined. Example 12 shows a nested condition using an IF–THEN–ELSE and an IF–THEN statement:

Example 12

```
Pseudocode_12: Exam_results
INPUT mark
IF mark >= 80
THEN OUTPUT "Excellent results!"
    OUTPUT "Please see your teacher"
ELSE IF mark >= 70
      THEN  OUTPUT "Satisfactory
      results!"
OUTPUT "Please await the end of term
report"
ENDIF
END
```

If the mark is 80 or greater, then the statements for 'Excellent results!' and 'Please see your teacher' will be output. Otherwise, if the mark is 70 or greater, then the statement for satisfactory results will be output. However, regardless of the mark, another statement to await the end of term report is also output.

Loops

The statements of a loop are arranged to depend on the result of a variable. Most loops cycle through the statements as follows:

- Input a starting value to a specific variable – this variable usually determines whether or not the loop executes or not.
- Test the variable against a condition.
- Execute the body of the loop.
- Update the value of the variable.

There are two types of loop statements:

- indefinite: when you do not know in advance how many times to repeat the loop (WHILE or REPEAT loops)
- definite: when you know in advance how many times to repeat the loop (FOR loop).

Indefinite loops

WHILE loop

Start value ___(then)___ check if condition is true ___(then)___ perform statements

REPEAT loop

Start value ___(then)___ perform statements ___ (then)___ check if condition is true

WHILE loop

The WHILE loop repeatedly executes one or more statements as long as the condition is true. The condition in a WHILE loop is tested at the beginning of the loop, so it is possible for the statement not to be executed at all.

The general form of the WHILE loop is:
WHILE (condition is true)
    Statement(s)

ENDWHILE

The ENDWHILE keyword indicates the end of the statements in the loop.
Note that statements are indented between WHILE and ENDWHILE statements.

Here are some examples that illustrate the WHILE loop. Where the number of times that the loop should be repeated may be known or unknown, the WHILE loop can still be used when the condition for stopping the loop is known.

Example 13

```
Pseudocode_13: Numbers_in_a_loop
number = 1
WHILE (number <= 3)
BEGIN
    number = number + 1
    OUTPUT "the number is", number
ENDWHILE
OUTPUT "out of loop"
END
```

These two statements are executed only in the loop

Note that the value 1 is assigned to the variable *number*. This is also called *initialising* a variable.

Here is how the loop is executed:

a Number containing the value 1 enters the loop.
The condition (number <= 3) is checked. That is (1 <= 3) is true.

b Enter the loop:
Number is increased to 2.
Output is 'the number is 2'.
The condition (number <= 3) is checked. That is (2 <= 3) is true.

c The loop is repeated:
Number is increased to 3.
Output is 'the number is 3'.
The condition (number <= 3) is checked. That is (3 <=3) is true.

d The loop is repeated:
Number is increased to 4.
Output is 'the number is 4'.
The condition (number <= 3) is checked. That is (4 <= 3) is now false.

e Leave the loop:
The next statement following the loop is executed (after the ENDWHILE statement).
The output is:

the number is 2
the number is 3
the number is 4
out of loop

Example 14

In this example, the indentation is used to indicate those statements that are within the WHILE loop, without using the BEGIN and ENDWHILE keywords.

```
Pseudocode_14: Younger_than_20
age = 15
WHILE (age < 20)
    Output "You are a teenager"
    age = age + 1
Output "You are not a teenager"
```

While the value of the variable age is less than 20, the statement 'You are a teenager' will be output. age is then increased by 1 and checked in the condition (age <20) before again passing through the loop. As soon as age reaches the value 20 then the statement 'You are not a teenager' is output.

Example 15

Let's now try an example of a loop where the number of times to repeat the loop is unknown. First, create an IPO chart that will repeatedly read each students' exam mark into a variable. It is not known how many exam marks are to be entered, but a mark with the value of –1 will indicate that it is the last mark. Once all marks are entered, the average mark is calculated and output.

Input	Processing	Output
mark	While (mark is not equal to –1) Add mark to total marks Calculate the average	average mark

An example of the corresponding pseudocode using the WHILE loop is shown below:

```
Pseudocode_15: Average_of_exam_marks
total = 0
count = 0
average = 0
OUTPUT 'enter a mark'
INPUT mark
WHILE (mark is not equal to -1)
     total = total + mark
     count = count + 1
     OUTPUT 'enter a mark'
     INPUT mark
ENDWHILE
average = total/count
DISPLAY average
END
```

The logic of the pseudocode is as follows:

- Three variables are initialised to store the total marks, the number of marks entered and the average mark.
- The user is prompted to enter the first exam mark.

L **a** Once the mark is not –1, the loop is entered.

O **b** The first mark is added to the total and counted as the first mark.

O **c** The user is prompted to again to enter another mark which is stored on input.

P **d** The loop is repeated at **a**.

- Once a mark of –1 is entered, the loop is exited.
- The average of the marks is calculated.
- The average mark is output.

Sometimes algorithms require the use of sequential statements, conditional statements and even loops. Example 15 illustrates the use of a WHILE loop; however, it can be further expanded to include a conditional statement. As you practise more with writing pseudocode and even writing programming code, you would want to test the program by entering some marks. Testing the algorithm is explained in a later section, but for now, consider what the output could be if a user enters −1 as the first exam mark.

- The condition in the WHILE loop is tested.
- The condition is now true since mark = −1.
- The loop is bypassed to calculate the average mark which would be average = 0/0.
- This would cause an error since 0/0 cannot be determined.

To avoid this error, after the ENDWHILE statement the following pseudocode for IF–THEN–ELSE statement can be added:

```
IF count = 0
THEN DISPLAY 'no marks entered'
ELSE
     average = total/count
     DISPLAY average
```

REPEAT loop

The REPEAT construct repeatedly executes one or more statements as long as the specified condition is false. Note that this condition is tested at the end of the loop, so the statement will always be executed at least once.

The general form of the REPEAT statement is:

```
REPEAT
     Statement(s)
UNTIL (condition is true)
```

Example 16

This example uses the REPEAT loop to output some numbers between 1 and 3, unlike Example 13, which used a WHILE loop.

```
Pseudocode_16: Numbers_in_a_loop
number = 1
REPEAT
    number = number + 1
    OUTPUT "the number is", number
UNTIL (number = 3)
OUTPUT "out of loop"
END
```

The variable number is first initialised to 1. Here is how the loop is executed:

a Number with the value 1 enters the loop.
b Number is increased to 2.
Output is 'the number is 2'.
The condition (number > 3) is checked.
2 > 3 is not true so the statements in the loops are executed again.
c Number is increased to 3.
d Output is 'the number is 3'.
Since 3 = 3, 'out of loop' is now output.
The output is:
the number is 2
the number is 3
out of loop

Example 17

```
Pseudocode_17: Attend_classes
INPUT day
REPEAT
    OUTPUT 'attend classes'
UNTIL (day = weekend day)
END
```

In this example, the statement 'Attend classes' will be output before it is checked to determine whether the data is, say, Saturday or Sunday. The statement is therefore output at least once before the condition is checked in the UNTIL statement. When the condition is checked and is true, then the next statement following the UNTIL statement is executed. This means that you will attend classes when there may be no school!

Example 18

Alternatively:

```
Pseudocode_18: Attend_classes
INPUT day
REPEAT
    OUTPUT "do not go to school"
UNTIL (it is a school day)
END
```

As an alternative example, the statement 'do not go to school' is output until the condition 'it is a school day' becomes true. Again, the statement is output at least once before the condition is checked in the UNTIL statement. This means that you will stay home one day when there may be school!

Example 19

```
Pseudocode_19: Under_20
age = 18
REPEAT
    OUTPUT "you are under 20 years old"
    age = age + 1
UNTIL (age = 20)
END
```

The statement will be output even though the value of age may be 20. This is because the condition (age = 20) is checked *after* the statement is output.

Example 20

Along with the WHILE loop, the REPEAT loop is also used when the number of times to repeat the loop is unknown. Let's look again at Example 15 which will repeatedly read students' exam marks into a variable.

Since it is not known how many exam marks are to be entered, a value of –1 will indicate that it is the last mark. Once all marks are entered, the average mark is calculated and output.

An example of the corresponding pseudocode using the REPEAT and IF–THEN–ELSE statements is shown below:

```
Pseudocode_20: Average_of_exam_marks_
using_REPEAT_loop
total = 0
count = 0
average = 0
REPEAT
     DISPLAY 'Enter mark'
     INPUT mark
     IF mark = -1
     THEN DISPLAY 'end of marks'
     ELSE
         total = total + mark
         count = count + 1
UNTIL mark = -1
IF   count = 0
THEN DISPLAY 'no marks entered'
ELSE
     average = total/count
     OUTPUT average
END
```

The logic of the pseudocode is as follows:

- Three variables are initialised to store the total marks, the number of marks entered and the average mark.

L **a** The user is prompted to enter the first exam mark.

O **b** If the mark is –1, the loop is exited.

O **c** Otherwise, the first mark is added to the total and counted as the first mark.

P **d** The loop is repeated at **a**.

- A mark of –1 must be entered to be outside the loop.
- Check if count is 0. This means no marks were entered so nothing to count and no average to calculate.
- Otherwise, the average of the marks is calculated.
- The average mark is output.

FOR loop

The FOR loop is used only when the start value and the end value are known.

The general form of the FOR loop is:
FOR <variable> = <start value> TO/DOWNTO <final value> DO
        Statements(s)
ENDFOR

Note:
- The variable must be in order so that it can be counted.
- The variable begins with the <start value>.
- The variable changes by 1 every time the statements are executed. TO counts up DOWNTO counts down.
- The loop terminates when the variable reaches the final value.
- ENDFOR denotes the end of the FOR loop.

The following examples written in pseudocode will help you understand the FOR loop.

Example 21

```
Pseudocode_21: School
Saturday = 2
Sunday = 3
FOR day = Saturday to Sunday DO
     OUTPUT "It is weekend"
ENDFOR
END
```

The variable *Saturday* is initialised with the integer 2, and the variable *Sunday* is initialised with the integer 3.

In the FOR statement, the variable *day* is assigned the first value of *Saturday* which is the number 2.

'It is weekend' is output.

day is then given the next value which is *Sunday*, represented by the number 3.

'It is weekend' is again output.

Since the values for the start and end of the FOR statement have been reached, the statement 'It is weekend' is therefore output twice, once for Saturday and once for Sunday.

Example 22

```
Pseudocode_22: Countdown
FOR countdown = 10 DOWNTO 1
     OUTPUT countdown
ENDFOR
END
```

The numbers 10, 9, 8, 7, 6, 5, 4, 3, 2 and 1 are output.

Example 23

```
Pseudocode_23: Daylight
FOR time = daybreak to sunset DO
     OUTPUT "it is not night"
ENDFOR
END
```

If a day consists of daybreak, morning, noon, afternoon, evening, sunset and night, then 'it is not night' will be printed six times, for each time it passes through the loop from *daybreak* to *sunset*.

Example 24

```
Pseudocode_24: Printing_numbers
FOR number = 1 to 2 DO
     Output "The number is", number
OUTPUT "Out of loop"
ENDFOR
END
```

The output here is:

The number is 1
The number is 2
Out of loop

Consider another algorithm which adds all the even numbers between 1 and 20 inclusive and then displays the sum. It uses a REPEAT loop. The equivalent pseudocode is:

Example 25

```
Pseudocode_25: Sum_of_even_numbers
sum = 0
count = 1
REPEAT
     IF count is even
     THEN sum = sum + count
count = count + 1
UNTIL count > 20
DISPLAY sum
END
```

Questions

1 Correct the following statements where each contains one error:

a REPEAT (count = count -2) THEN count = 25

b FOR (count<= 20) DO
count = count *5

c IF total = count * 5
WHILE display count

2 State which of the following statements define WHILE and REPEAT loops:

a Loop A

- **i** executed at least once
- **ii** condition is checked after statements are completed
- **iii** statements are performed until condition is TRUE.

b Loop B

- **i** not always executed
- **ii** condition is checked before statements are completed
- **iii** statements are performed until condition is FALSE.

3 Consider the following algorithms:

Pseudocode_9.3.3left	Pseudocode_9.3.3right
BEGIN Blu = 4 Met = 5 INPUT Num Blu = 2 * Num + Blu Met = Blu + Num - Met DISPLAY Blu, Num, Met END	WHILE word <> 'page' INPUT word IF word = 'page' THEN Display 'OK' ELSE Display 'Oh No' ENDWHILE

a Write an example from each algorithm that represents a(n):

- **i** variable
- **ii** constant
- **iii** keyword
- **iv** arithmetic operator
- **v** Boolean operator.

b State whether the left algorithm contains any of the following:

- **i** loop
- **ii** conditional statement
- **iii** sequential statement
- **iv** output statement.

4 You wish to input each mark from four class tests, then calculate and print the total mark. Write the pseudocode using:

a sequential statements

b a WHILE loop

c a REPEAT loop

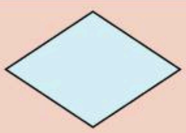
d a FOR loop.

5 Write pseudocode to input an unknown number of integers. The value –1 should stop reading numbers and calculate the average.

9.4 Flowcharts

Flowcharts are algorithms that use symbols to depict the input, processing and output of data and information. These symbols use the same terms to illustrate the flow of data as the statements in pseudocode. Table 9.2 shows the symbols with their descriptions.

Table 9.2 *Flowchart symbols*

Symbol	Name	Description
	Terminator	Used to identify the start and end of a flowchart
	Input / Output	Used to accept data or to output information
	Process	Statements in this symbol perform calculations
	Decision	Also called a conditional statement. Used to ask a question to determine the next step or option. One line in but more than one out
	Connector	A link to an external element or detail not included in the visible flowchart
→	Flow lines	Lines with arrow heads determine the flow of data from one symbol to another

Each symbol represents an action or condition. Within most symbols, text is used to describe what is happening to the data, while the arrows indicate the flow of data from one symbol to the next.

Some rules for flowcharts include:

- Every flowchart must have a Start symbol and a Stop symbol, unless you are drawing a section of a flowchart. The Start and Stop symbols are called the terminals or terminators.
- Use arrow heads on flow lines where the direction of flow may not be obvious.
- The main symbols used in a flowchart are the Decision (also known as Selection) and the Process (or Sequence) symbols.
- The flow of sequence is generally from the top of the page to the bottom of the page. However, this can vary: sometimes there are loops which need to flow back to a process or decision.

There are also some important rules for the symbols. These rules also generally apply to algorithms and pseudocode:

- Processes have only one entry point and one exit point.
- Lines with arrow heads indicate the flow of sequence.
- Decisions have only one entry point, one TRUE (or Yes) exit point and one FALSE (or No) exit point. You should also know when to use the IF–THEN and IF–THEN–ELSE structures.
- The REPEAT loop has a process before the decision. That is, a REPEAT loop will always execute the process at least once. This is an important point to remember.
- The WHILE loop is generally the reverse of the REPEAT loop: the decision comes first, followed by the process. The WHILE loop is usually drawn so that it loops *while* the condition is true, the REPEAT loops *until* the condition becomes true.

It is important that you practise drawing flowcharts since they illustrate the orderly flow of data in an algorithm. If a flowchart is not created properly it can cause confusion and result in statements that are not logical or produce incorrect information. You should first practise drawing the symbols and then draw some of the sample flowcharts presented in the examples so that you can compare and improve as you continue to practice.

The following flowcharts represent some of examples that were written using pseudocode in the previous section.

Sequence statements

Similar to pseudocode, where a set of statements are executed one after the other from the first statement to the last, flowcharts also depict the sequence of statements by using symbols.

As shown in Figure 9.2, a flowchart has Start and Stop symbols. There are also small circles called connector symbols which indicate that the flowchart is part of a larger one (Fig 9.1). Sequential statements are joined by directional arrows. Each symbol has an arrow pointing to it and another arrow pointing away from it to another symbol. The symbol also contains text that explains the processing to be carried out.

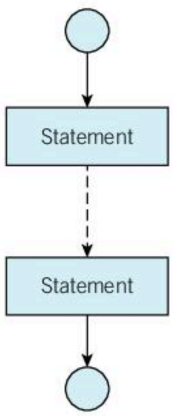


Fig 9.1 Flowcharts have sequential statements

Consider a flowchart created from Example 5 which finds the sum of three numbers (Fig 9.2). The IPO chart and pseudocode are also given here for comparison.

Example 26

IPO chart to find the sum of three numbers.

Input	Processing	Output
number1 number2 number3	Add the three numbers together	The result of the addition

```
Pseudocode_26: Add_three_numbers
INPUT number1, number2, number3
Add number1 + number2 + number3
OUTPUT result of number1 + number2 +
number3
END of pseudocode
```

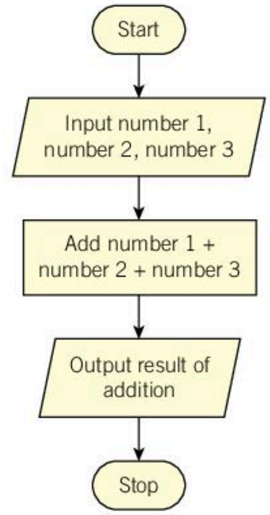


Fig 9.2 Flowchart for finding the sum of three numbers

The flowchart shows a sequence of symbols from the Start symbol to the Input symbol, Process symbols, Output symbol and Stop symbol. The text within each symbol is similar to that of the IPO chart and is an example of pseudocode.

Example 6 in the previous section finds the average of two temperatures. The flowchart is shown below. Notice that the text in the process symbol does not need to specify the precise calculation. A description of what processing is carried out or a series of symbols that detail each calculation are both acceptable.

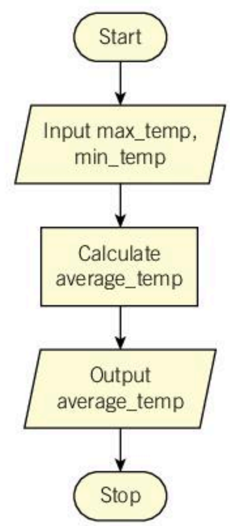


Fig 9.3 A flowchart for Example 6

Conditional statements

Conditional statements for flowcharts use IF–THEN or IF–THEN–ELSE structures.

IF–THEN structure

The flowchart for the IF–THEN structure is shown in Figure 9.4. Note that the condition symbol usually contains a question where the answer is one of only two options, such as yes or no, true or false. The conditional statement can selectively skip or include statements based on the outcome of the condition.

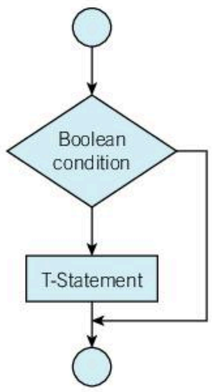


Fig 9.4 Flowchart for the IF–THEN structure

Figure 9.5 shows the flowchart based on Example 8b. The algorithm accepts a birth year, calculates the age based on the current year and then displays a comment if the student is a teenager. This flowchart contains Process, Input/Output and Decision symbols (also

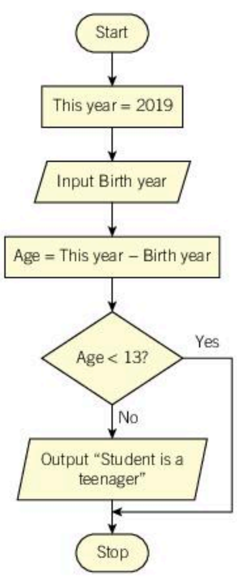


Fig 9.5 Flowchart that calculates an age to determine if the student is a teenager

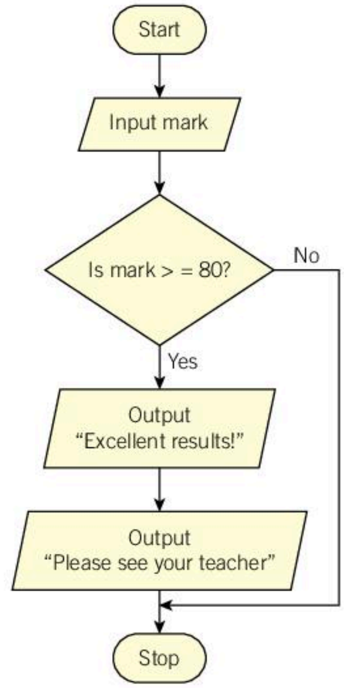


Fig 9.6 A flowchart for Example 9b

the Start/Stop symbols). A Process symbol is used to initialise the variable *This year*.

The IF–THEN Decision symbol in Figure 9.6 shows that the two statements are output if the condition is true, otherwise they are skipped to join the directional arrow below the last output statement. The figure also shows two consecutive Output symbols, but depending on the algorithm, both output statements can be placed in one symbol. Notice that the 'Yes' and 'No' placed near to the Decision symbol are in different locations when compared to the flowchart in Figure 9.5. These labels must match the logic of the algorithm and can therefore be used at the appropriate point of the symbol.

IF–THEN–ELSE structure

The flowchart for the IF–THEN–ELSE structure is shown in Figure 9.7. Note that the condition symbol again contains a question. However, depending on the result of the question, the flow of data is directed to different statements.

Figure 9.8 shows the flowchart based on Example 10, which illustrates the IF–THEN–ELSE structure. Three numbers are input. They are added, and the

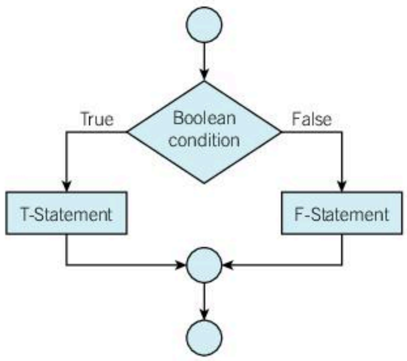


Fig 9.7 Flowchart for the IF-THEN-ELSE structure

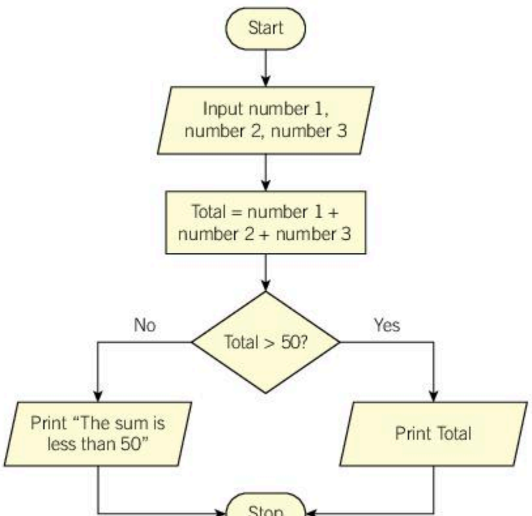


Fig 9.8 Flowchart for the IF–THEN–ELSE structure that determines whether a number is greater than 50

result is stored in a variable named total. If the total is greater than 50, then the flowchart displays the total, otherwise it displays a comment.

Figure 9.9 expands the flowchart of Figure 9.5 to show the IF–THEN–ELSE structure on determining whether a student is a teen or not.

Nested conditions

Figure 9.10 illustrates a combination of two conditional structures that output statements based on marks. The accompanying pseudocode is shown in Example 27. This flowchart shows how the flow of data does flow from the start to the stop symbol even though the statements are not from top to bottom. As you trace the flowchart, notice that regardless of the mark, the same final statement will be output.

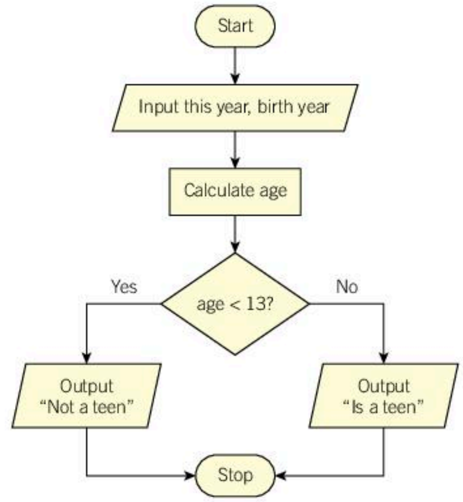


Fig 9.9 A flowchart that displays different comments based on an age

Example 27

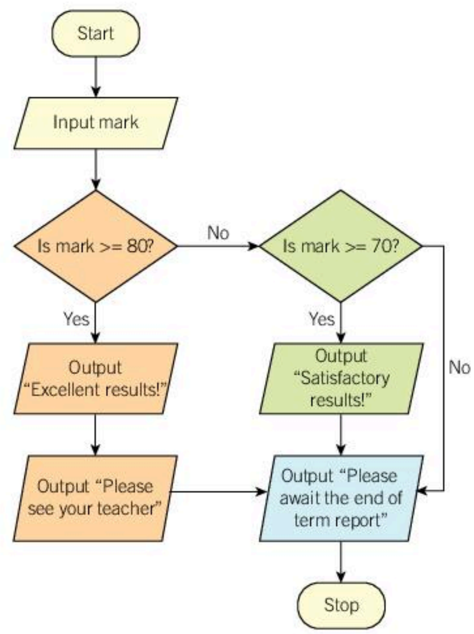


Fig 9.10 A flowchart can combine conditional structures that output statements based on the result of a mark

```
Pseudocode_27: Exam_results
INPUT mark
IF mark >= 80
THEN OUTPUT "Excellent results!"
     OUTPUT "Please see your teacher"
ELSE IF mark >= 70
     THEN  OUTPUT "Satisfactory results!"
OUTPUT "Please await the end of term
report"
ENDIF
END
```

Loops

The WHILE and REPEAT loops are used when you do not know in advance how many times to repeat the loop. The FOR loop is preferred when you *do* know the starting and ending values or the number of times to repeat the loop.

Figures 9.11 and 9.12 compare the flowcharts of the WHILE and REPEAT structures.

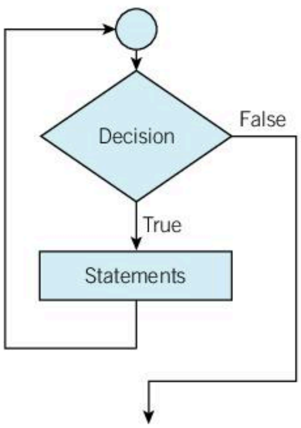


Fig 9.11 Flowchart for the WHILE loop

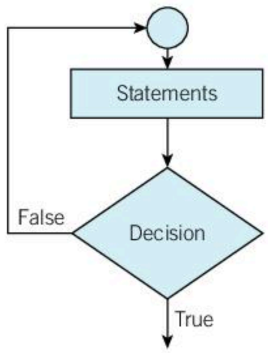


Fig 9.12 Flowchart for the REPEAT loop

Note where the Decision symbols are located in each loop. The condition in a WHILE loop is tested at the beginning of the loop, so it is possible for the statement not to be executed at all. The condition in the REPEAT loop is tested at the end of the loop, so the statement will always be executed at least once.

Examples 28 and 29

Compare the two flowcharts in Figures 9.13 and 9.14. Each flowchart displays some numbers between 1 and 4 based on a condition in each loop.

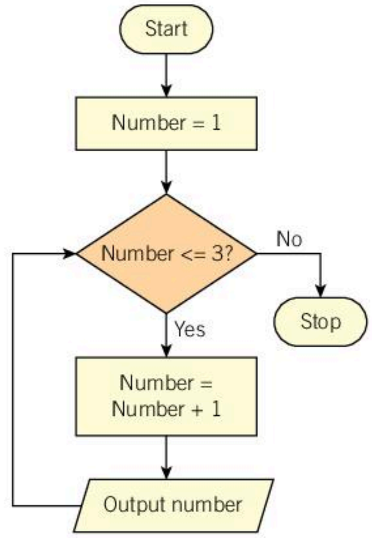


Fig 9.13 Using the WHILE loop to output numbers between 1 and 3 based on a condition

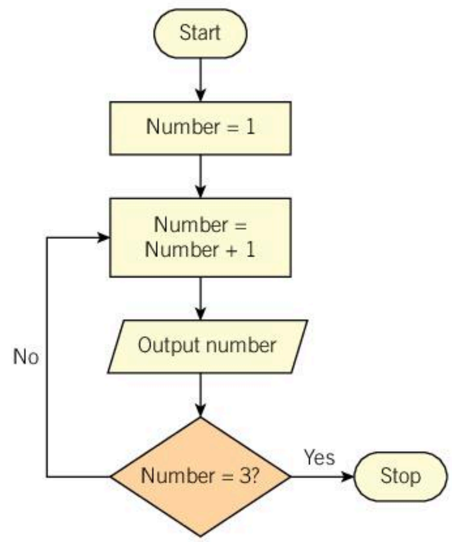


Fig 9.14 Using the REPEAT loop to output numbers between 1 and 3 based on a condition

The pseudocode for the WHILE and REPEAT loops are again shown for comparison. The FOR loop can be represented by either the WHILE or the REPEAT loop.

Pseudocode_28: while loop example	Pseudocode_29: repeat loop example

number = 1
WHILE (number <= 3) DO
BEGIN
    number = number + 1
    OUTPUT "the number is", number
ENDWHILE
OUTPUT "out of loop"
END
	number = 1
	REPEAT
	    number = number + 1
	    OUTPUT "the number is", number
	UNTIL (number = 3)
	OUTPUT "out of loop"
	END

The flowchart in Figure 9.15 adds together all the even numbers between 1 and 6 and then displays the sum.

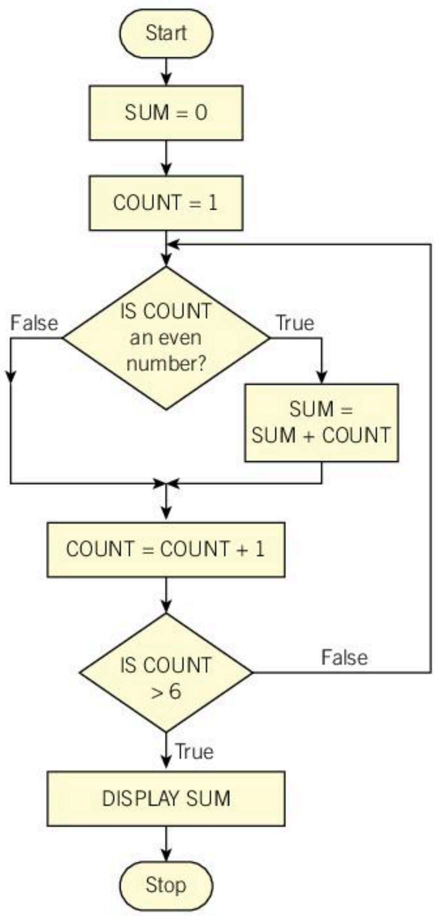


Fig 9.15 Flowchart adds all even numbers between 1 and 6

Pseudocode may appear quite simple by comparison to flowcharts, so why would you want to use flowcharts? The major reasons are that a flowchart:

- is easier to read
- more closely follows a standard, using symbols, unlike pseudocode
- lends itself more readily to conditional and control program structures.

As you continue to practice drawing flowcharts remember that:

- Every flowchart has a start and end point.
- The Process symbol can be anything from completing a calculation to describing an action. It is represented by a rectangle containing the text with the description.
- If there is a question or condition, it is most likely placed in a Decision symbol.
- The connection of 'what symbol follows next' is shown with arrows between symbols.

Questions

1 Name and draw the symbol that is suitable for each of the following statements:
- **a** indicates the end of a flowchart
- **b** performs a calculation
- **c** directs the flow of data to another symbol
- **d** asks a question
- **e** prints a result.

2 Draw the flowchart symbol including suitable text for each of the following statements:
- **a** display the message 'Call a taxi'
- **b** read a value into a variable *age*
- **c** add 15 to a variable *age* and store the result in a variable *old*
- **d** double the value of a variable named *cost*
- **e** ask if the taxi has arrived.

3 Use the pseudocode below to draw the corresponding flowchart segment:

```
Pseudocode_9.4.3:
WHILE word <> 'page'
     INPUT word
     IF word = 'page'
     THEN DISPLAY 'OK'
     ELSE DISPLAY 'Oh No'
ENDWHILE
```

In many of the examples in this chapter you may have seen fragments of pseudocode such as (age < 20) and (number < 3). These conditions are evaluated in the Arithmetic and logic unit (ALU) of the CPU. Let us look at them in more detail.

Arithmetic operators

These perform basic mathematical operations such as addition, subtraction, multiplication or division to produce a result which is a number.

Table 9.3 *Arithmetic operators*

Arithmetic operator	Meaning (example)
+ (plus sign)	addition (3+3)
– (minus sign)	subtraction (3–1)
* (asterisk)	multiplication (3*3)
/ (forward slash)	division (3/3)
MOD	produces the remainder in the result
DIV	integer division–produces only the whole number in result (5/2 = 2)

Relational operators

These compare two quantities with each other. You will see these operators in algorithms where there is a condition. The algorithm relies on whether the result of a condition is true or false to know how to proceed to the next set of statements. This may include exiting a loop or jumping to another set of statements. In Table 9.4 the variable *age* **= 20** is used as the example to explain the different operators.

Table 9.4 *Relational operators*

Logic operator	Meaning	Example
=	equal to	age = 20
>	greater than	age > 19
>=	greater than or equal to	age >= 19
<	less than	16 < age
<=	less than or equal to	19 <= age
<>	not equal to	age <> 19

Logical operators

The conditional, WHILE, REPEAT and FOR statements compare values in order to determine a result. For example, WHILE number <= 3, IF mark = –1 and IF age < 13 must each produce a result that is either TRUE or FALSE. That is, when two values are compared using these operators, the result is either TRUE or FALSE.

Let's look at the example WHILE number <= 3 more closely.

If the variable *number* contains the value 2, then 2 is compared with 3 to determine if 2 is less than or equal to 3 (2<=3), which is TRUE. The outcome of *number* **<= 3** is therefore TRUE. However, if *number* contains the value 4, then the result of the condition (4<=3) is FALSE.

The NOT operator

The result of a condition has one of two options. Examples are TRUE or FALSE, Yes or No, Accept or Not Accept, 1 or 0. That means a result is not TRUE, then it is FALSE. If is not 1, then it is 0.

The following tables use examples to illustrate how the NOT, AND and OR operators can be applied. These tables are also called **truth tables**.

Suppose a line of pseudocode contained the statement **IF day = Sunday**. Then based on the result (TRUE or FALSE) other statements will be performed.

Table 9.5 shows two examples for a typical condition IF day = Sunday and the use of the NOT operator. The condition can be written in these ways:

```
IF day is NOT Sunday
IF day is NOT equal to Sunday
IF day <> Sunday
NOT(IF day = Sunday)
```

If the result is TRUE, then a day other than Sunday would produce a result of FALSE.

Table 9.5 *Truth table for NOT*

If day = Sunday	NOT (If day = Sunday)		If day = Sunday	NOT (If day = Sunday)
TRUE	FALSE		1	0
FALSE	TRUE		0	1

The AND operator

Suppose a segment of pseudocode indicates that a student is promoted to the next class if an exam mark in the third term is 70 or greater.

```
IF (mark >= 70) AND (term = 3)
THEN Display 'Promoted'
```

The condition of both values must be true.

- If the value of one condition is TRUE and the value of the next condition is TRUE, then the result of both conditions is TRUE.
- If any one of the values is NOT TRUE (FALSE) then the result is also FALSE.

Table 9.6 *Truth table for AND*

mark >= 70	Term = 3	(mark >= 70) AND (term = 3)	(mark >= 70) AND (term = 3)
TRUE	TRUE	TRUE	Promoted
TRUE	FALSE	FALSE	Not promoted
FALSE	TRUE	FALSE	Not promoted
FALSE	FALSE	FALSE	Not promoted

The rightmost column shows the result for the example given.

In creating a truth table, you should list all the possible combinations for the conditions so that you can determine the outcome of each. Notice that Table 9.6 contains four rows of combinations of TRUE and FALSE. To calculate how many rows of options are needed, you can use the formula $2^{\text{number of conditions}}$. The number 2 represents the two options available, such as TRUE or FALSE, Yes or No, 1 or 0, Promoted or Not promoted.

Since there are two conditions (**mark >= 70**), (**term = 3**), the formula becomes $2^{\text{number of conditions}} = 2^2 = 4$ possible combinations of results.

Now that we know we need four rows:

- Use the first column to fill half of the rows (that is 4 / 2 = 2) with TRUE and half with FALSE. So, rows 1 and 2 contain TRUE and rows 3 and 4 contain FALSE.
- Use the second column to alternate TRUE and FALSE.
- Use the third column and any additional columns to fill in the results.

Row	Column 1 Condition1	Column 2 Condition2	Column 3 Outcome/Result
1	TRUE	TRUE	
2	TRUE	FALSE	
3	FALSE	TRUE	
4	FALSE	FALSE	

The OR operator

OR works slightly differently. Suppose a segment of pseudocode indicates that a student is promoted to the next class if an exam mark is 70 or greater or the student ranked in the top 10 of the class.

```
IF (mark >= 70) OR (rank <= 10)
THEN Display 'Promoted'
```

- If the value of one condition is TRUE, then the result is TRUE.
- However, if the value of all the conditions are FALSE then the result is FALSE

Table 9.7 *Truth table for OR*

mark >= 70	rank <= 10	(mark >= 70) OR (rank <= 10)	(mark >= 70) OR (rank <= 10)
TRUE	TRUE	TRUE	Promoted
TRUE	FALSE	TRUE	Promoted
FALSE	TRUE	TRUE	Promoted
FALSE	FALSE	FALSE	Not promoted

Combinations of operators

As you practise the use of operators in algorithms as pseudocode or flowcharts, longer expressions can be expected.

For example, if an exam mark in the third term is 70 or greater and the student is also ranked in the top 10 of the class, then the student is promoted to the next class and given a plaque:

```
IF (mark >= 70) AND (term = 3) AND
(rank <= 10)
THEN Display 'Promoted and awarded a
plaque'
```

The values for all three conditions therefore must be TRUE in order to display 'Promoted and awarded a plaque'.

Expressions can also be replaced with a character, such as A or B, or a phrase for ease of completion. Then the basic expressions can be written as NOT A, A AND B, A OR B . This also makes it easier to write combinations of operators.

Example 30

```
IF (mark >= 70) OR (rank <= 10)
THEN Display 'Promoted'
```

Here we still have two conditions:

```
Let A represent mark >= 70
Let B represent rank <= 10)
```

Using the representations of A and B above, use TRUE and FALSE to find the result of A OR (NOT B).

First, create the truth table with A and B, then add another column and use the pattern from Table 9.5 to find NOT B:

A: mark >= 70	B: rank <= 10	NOT B
TRUE	TRUE	FALSE
TRUE	FALSE	TRUE
FALSE	TRUE	FALSE
FALSE	FALSE	TRUE

Next, using the values of A and NOT B, and the pattern for the truth table for the OR operator from Table 9.7, gives:

A: mark >= 70	B: rank <= 10	NOT B	A OR (NOT B)	Display
TRUE	TRUE	FALSE	TRUE	Promoted
TRUE	FALSE	TRUE	TRUE	Promoted
FALSE	TRUE	FALSE	FALSE	Not promoted
FALSE	FALSE	TRUE	TRUE	Promoted

The only outcome that is FALSE for A OR (NOT B) indicates that if a student's exam mark is *not* 70 or greater or the student is ranked in the top 10 of the class, then the student is *not* promoted.

Questions

1 Identify the arithmetic or relational operator used in each of the following statements:
   - **a** An area code must be three digits.
   - **b** The cashier deducted $2 for the sale item.
   - **c** There were two more passengers in the car.
   - **d** There must be 15 or more passengers on board.

2 Write the following statements using relational operators. The first one is done for you.
   - **a** There are three sisters. *Answer: sisters = 3*
   - **b** Citizens must be at least 18 in order to obtain a picture ID.
   - **c** There are 65 students with passes at Grade II.
   - **d** Employees have at most four weeks of vacation.
   - **e** Pension is from age 65 and older.
   - **f** A cheque is not equal to cash.

3 The variable LET contains the number 8 and CHR contains the number 24. Write the answer to the following statements, as either TRUE or FALSE:
   - **a** (LET > 16)
   - **b** (CHR < LET)
   - **c** (LET > 16) OR (CHR < LET)
   - **d** (LET > 16) AND (CHR < LET)
   - **e** (CHR < 16) OR (LET < CHR)

4 Consider the following algorithm:

```
password = 'page'
count = 1
word =' '
WHILE (word <> password) and
(count <=3)
INPUT word
count = count + 1
IF word = password
THEN Display 'Access'
ELSE Display 'Forgot password'
```

Identify:

a an arithmetic operator

b a relational operator

c a logical operator.

5 You are to create a truth table for the following statement:

```
IF (word = password) AND (count <=3)
THEN Display 'Access'
ELSE Display 'Forgot password'
```

a Identify:

  i the conditions

  ii the two outcomes (results) from the statement

  iii the number of possible options/rows needed for the truth table.

b Draw the truth table.

6 How many possible combinations of options (rows) will be needed for a truth table that has three conditions?

7 Let A represent Saturday and B represent It's raining. The outcomes are if TRUE, do some gardening, and if FALSE, go to town. Create truth tables for the following Boolean expressions:

a (NOT A) OR B

b NOT (A OR B)

c NOT (A AND B)

d A AND (NOT B).

Desk checking is the process of reviewing an algorithm for the correct processing and output. You do this by manually executing the steps in the algorithm one by one, while keeping track of the results. We started desk checking with Example 12 by going through each loop and explaining the output.

The logic of your algorithm is an important part of testing. Using a trace table will help you to test and verify your algorithms.

An algorithm is a sequence of steps which seek to solve a problem. If you 'freeze' the algorithm at any point then you have a 'snapshot' of the state of all the variables at that point.

The trace table is a very useful tool, which allows you to see the state of your algorithm with as much detail as you wish. Each row of the table shows the state of one step in the algorithm and each column shows the value of a variable at that step. The trace table allows you to check the algorithm for errors.

Example 31

Complete the trace table for the following algorithm, given that the number 4 is the input value for QNTY.

```
READ QNTY
FOR SOLD = 1 to QNTY DO
INV = QNTY - SOLD
VAL = 5 * INV - SOLD
END
PRINT VAL
```

QNTY	SOLD	INV	VAL
4			
4			
4			
4			

Start by replacing each QNTY in the algorithm with the number 4:

```
READ 4
FOR SOLD = 1 to 4 DO
INV = 4 - SOLD
VAL = 5 * INV - SOLD
END
Print VAL
```

Now, the FOR loop tells you that SOLD must go from 1 to 4. You can therefore fill in the column labelled 'SOLD' with the numbers 1, 2, 3 and 4.

The next step is to perform the two calculations within the loop.

When SOLD is 1, INV = 4 – 1 = 3.

Write the number 3 in the table under INV, in the row where SOLD = 1.

The number 3 can now be used in the second calculation, giving VAL = 5 * 3 – 1.

Remember the rules in mathematics: BODMAS (Brackets – Order – Division – Multiplication – Addition – Subtraction). They tell you in which order to do the arithmetic operations. Computers follow the same rules.

Therefore VAL = (5*3) – 1 = 15 – 1 = 14

Write 14 in the row where INV = 3.

QNTY	SOLD	INV	VAL
4	1	3	14
4	2		
4	3		
4	4		

When SOLD is 2, INV = 4 – 2 = 2. Write the number 2 in the table in the row where SOLD = 2.

Now INV = 2, so VAL = 5 * 2 – 2 = (5*2) – 2 = 8

Write 8 in the row where INV = 2.

QNTY	SOLD	INV	VAL
4	1	3	14
4	2	2	8
4	3		
4	4		

When SOLD is 3, INV = 4 – 3 = 1. Write the number 1 in the table in the row where SOLD = 3.

Now INV = 1, so VAL = 5 * 1 – 3 = (5 * 1) – 3 = 2

Write 2 in the row where INV = 1.

QNTY	SOLD	INV	VAL
4	1	3	14
4	2	2	8
4	3	1	2
4	4		

When SOLD is 4, INV = 4 – 4 = 0. Write the number 0 in the table in the row where SOLD = 4.

Now INV = 0, so VAL = 5 * 0 – 4 = (5 * 0) – 4 = –4

Write –4 in the row where INV = 0.

QNTY	SOLD	INV	VAL
4	1	3	14
4	2	2	8
4	3	1	2
4	4	0	–4

The maximum value in the loop has been reached, so you move on to the next line in the algorithm, which is to print VAL. The very last value of VAL in the algorithm is –4.

So when you freeze the algorithm, the last row of the table shows the values at that time. For this example, when QNTY = 4, you have SOLD = 4, INV = 0 and VAL = –4.

Questions

1 The marks 25, 30, 12, 10, –1 are to be entered using the following algorithm. Trace the values of total, count and average as the marks are entered.

```
Pseudocode_9.6.1: Calculate_average
START
total = 0
count = 0
average = 0
OUTPUT "enter a mark"
INPUT mark
WHILE (mark is not equal to -1)
     total = total + mark
     count = count + 1
     OUTPUT "enter a mark"
     INPUT mark
ENDWHILE
average = total/count
DISPLAY average
END
```

2 Trace the variable mark and the output when the marks 65, 71 and 82 are entered:

```
Pseudocode_9.6.2: Exam_results
START
INPUT mark
IF mark >= 80
THEN  OUTPUT "Excellent results!"
      OUTPUT "see your teacher"
ELSE  IF mark >= 70
      THEN  OUTPUT "Satisfactory
results!"
ENDIF
OUTPUT "await end of term report"
ENDIF
END
```

Multiple choice questions

1 The two main phases of problem solving comprise __________ and __________.

a algorithm, execution
b algorithm, implementation
c definition, execution
d definition, implementation.

Questions 2 to 4 refer to the diagram below.

Column 1	Column 2	Column 3
Accept letter	IF letter is A, B or C	Print grade
	THEN grade = 'P'	
	ELSE grade = 'F'	

2 Columns 1, 2 and 3 represent:

a read, store and write
b output, store and input
c write, process and read
d input, process and output.

3 Column 2 is an example of a __________ statement.

a logical
b looping
c sequential
d conditional.

4 The terms 'letter' and 'grade' in column 1 are:

a constants
b keywords
c variables
d subroutines.

5 The __________ loop executes a process statement before a decision.

a DO
b REPEAT
c WHILE
d UNTIL.

6 An example of a relational operator is:

a /
b >
c NOT
d AND.

7 All flowcharts have a:

a truth table
b start symbol
c WHILE loop
d conditional statement.

8 A(n) __________ loop must have start and end values.

a FOR
b IF
c REPEAT
d WHILE.

9 The process of reviewing an algorithm for the correct processing and output is known as:

a compiling
b debugging
c pseudocode
d desk checking.

10 'Freezing' an algorithm at any point to view a 'snapshot' of the state of all the variables at that point is achieved by using a:

a program
b trace table
c flowchart
d truth table.

Short answer questions

11 You were asked to write a short program that will accept information about companies in six countries and the number of employees requiring training. There is one trainer for every 40 employees. However, another trainer is needed if there are at least 15 or more employees over the requirement.

A sample of the data to be entered is shown below:

CO_ID	Country	Company	NumtoTrain
6985	Guyana	Rumaba	56
6987	Trinidad	Mariob	45
7295	Jamaica	Courtstreet	87
7324	Barbados	EveryInc	42
7361	Antigua	St. Micks	50
7455	Belize	Maggow	68

a On entering a country's code, name, company and the number of employees to be trained, the program will calculate and print the number of trainers assigned.

i Identify the variables required.

ii State the data type for each of the variables listed in part i.

iii Determine the output for each of the following statements if numberofempl is 56:

```
numberofempl DIV 30
numberofempl MOD 30
```

iv Explain the purpose of the two statements in part iii.

v Create an IPO chart for entering one country's data.

b The IPO chart should be drawn and sent to ten programming personnel for comments by the end of the day.

i Suggest an appropriate application that should be used to draw the IPO chart.

ii Describe the best method to send the chart to the personnel.

Iii Explain one disadvantage of the method you describe in part ii.

12 The following pseudocode was written in preparation for writing the program:

Initialise variables
Prompt to enter data in each variable
Calculate the number of trainers
Calculate the number of extra trainers required
Output total number of trainers needed

a Draw a flowchart to represent the five lines of pseudocode.

b Write additional pseudocode to add further detail to line 1.

c Write a conditional statement that would calculate the number of extra trainers required for line 4.

d The program should be able to enter data for a maximum of six countries. Explain which loop would be most suitable.

e Identify three examples of data that could be used to test the algorithm for correctness.

PROGRAM IMPLEMENTATION

10.1 Programming languages

Chapter 9 introduced the concept of problem-solving by writing algorithms and drawing flowcharts. It is during the implementation phase that an algorithm must be converted into actual programming language statements called **source code**. In this chapter, we share some examples of programming languages to introduce the process of writing short programs.

Implementation phase

In this phase, there are four main steps:

1 Translate your algorithm into a programming language such as BASIC, Pascal, C or C++, or Visual Basic for Applications (VBA). If you have a correct and precise algorithm, the translation should be almost line-by-line.
2 Locate and correct any errors in the code such as:
   - syntax errors, which are the errors resulting from incorrect use of the programming language syntax or violation of syntax rules
   - logic errors made by the programmer, such as those made by using wrong signs or arithmetic operators.
3 Execute the program code. This includes using test data to ensure that the program is working as expected, and can produce error messages as needed.
4 Maintain the program. This includes documenting the program throughout the coding process by writing comments on how to use the program, as well as comments within the program on how it works.

Choosing the programming language

Programming is the art of writing the solution to a problem using a language that a computer can interpret. A programmer actually instructs the computer how to solve a problem since it cannot come up with a solution to a problem itself.

A computer program is a set of instructions that tells a computer what to do and how to do it. These instructions are usually converted into a sequence of numeric codes called machine code which is stored in memory. The central processing unit (CPU) interprets this code in order to carry out the instructions of the program.

First, you select the type of programming language that is suitable for your task. There are many programming languages that can be used to write programs or create other kinds of software. These languages are grouped into two categories:

- low-level languages
- high-level languages.

Low-level languages

These languages are machine-dependent. That is, the code written can only be understood by the particular computer or processor that was used to write the code.

Machine language uses the digits 0 and 1 to make up the binary code. An instruction might be written as 10110000 01100001.

- Advantage: code runs very fast and efficiently because it is directly executed by the CPU.

- Disadvantage: the programmer may become confused with the massive amount of 0s and 1s in the program. It is also machine-dependent.

Assembly language has the same structure and commands as machine language but allows programmers to use abbreviated words, called mnemonics, instead of binary. So instead of writing code as 10110000 01100001, the equivalent assembly language code may be 'add A, B', generally meaning 'add the contents of A and the contents of B'.

- Advantage: can be easily converted to machine code by a program called an assembler.
- Disadvantage: still difficult to understand compared to the high-level languages. Still machine-dependent.

High-level languages

High-level languages are different from low-level languages in that they are not machine-dependent. Therefore, programs written on one computer can generally be used on another similar computer. They also use keywords similar to English and are easier to write.

These languages are designed to be easier for you to understand. They are converted to machine code, rather like translating from one language to another, so that the computer can carry out the instructions in the CPU.

- Advantage: can use English-type words to write program code, making it easier to create.
- Disadvantage: programs have to be converted to machine language.

Table 10.1 *Examples of high-level programming languages*

Pascal
Named after the 17th century mathematician Blaise Pascal. A language that uses structured programming, mostly used for teaching purposes. Pascal is an easy to learn language that is an alternative to BASIC.
VBA
Visual Basic for Applications, is a programming language developed by Microsoft and derived from BASIC. Programming in VBA uses a graphical user interface using drag-and-drop techniques on a form (window). Controls, such as text boxes and buttons, are used to design the layout on the form to work with Microsoft applications such as Word, Excel and Access.

The other sections in this chapter focus on writing the program, running or executing the code, debugging techniques, testing the program with data and documentation.

Question

1 Explain the difference between low-level languages and high-level languages.

Although different programming languages have slightly different code and data types, for the most part writing the code becomes easy with practice. The 2020 syllabus has not specified a recommended programming language, but it is best to choose a language that is not too complicated to learn. Examples of programs are shown in four languages for illustrative purposes.

Once the programming language has been selected, you can start writing the program. Once you have designed your algorithm and tested it on paper, you need to use a text editor to type the program. Most programs provide an editor that can be used to type your programming code. Most programming languages have different syntax and semantics which you must follow.

Syntax is the very precise way in which the statements in a program must be written in order to be understood. It is a set of rules for combining the various elements that make up a programming language. The syntax allows the programmer to create a correctly structured statement that is 'legal' – although it does not guarantee that the statement will be useful!

Semantics is the meaning associated with the words, symbols and punctuation that make up the language. For example, in Pascal, a semicolon (;) represents the end of a statement, while in other languages it may have another meaning. Statements are constructed from the various program elements; the overall meaning of the statement is determined by the language semantics.

Program structure

Nearly all structured programs share a similar overall structure:

- statements to establish the start of the program: could include program headers or comments to state the name of the author and a date that the program was written
- declarations of variables and types
- Program statements (blocks of code), which include:
  - constructing arithmetic, relational and Boolean expressions (AND, OR, NOT) using appropriate operators
  - implementing the remaining pseudocode constructs such as conditional (IF), iteration constructs (looping) and terminating conditions
  - formatting output in a user-friendly manner.

Sample program

The following is a simple example of a program written in three different programming languages: BASIC, Pascal and VBA in Microsoft Excel. These programs each show the program header, if required, and code to output the line 'Hello to everyone' on the computer screen. There is also a comment indicating the purpose of the program. You should include comments within the program when you write your code. There are no variable declarations in this first example, and you do not need to understand every line of code; just become familiar with the pattern of how the code is written. Some code may also vary since each compiler has slight variations in their syntax requirements.

Example 1

Programming language: BASIC

REM Output a sentence	← Optional comment on the purpose of the program
PRINT Hello to everyone	← Output statement

Programming language: Pascal

Program sentence;	← Keyword Program followed by name of program then a semicolon(;)
{To output a sentence}	← Comment on the purpose of the program
Begin	← Keyword to indicate statement(s) will follow below
Writeln('Hello to everyone');	← Output statement
End.	← Keyword for end of program code

Visual Basic for Applications (VBA)

' To output a sentence	← Comment on purpose of the program
Private Sub CommandButton1_Click()	← Keywords for start of code
MsgBox "Hello to everyone"	← Keyword to send the statement to the screen
End Sub	← Keyword for end of program code

In order to use a variable within a program, the compiler needs to know in advance the type of data that will be stored in it. For this reason, you must declare or state the variables you are using at the very start of the program. Variable declaration means giving a new name and a data type for the variable, for example, age: integer.

You should use meaningful variable names in your programs, so that if you or someone else needs to review the programming code later, the variables will be easy to remember and understand. In the following example programs, three variables named age, cost and class are declared. Each variable is then used in the programs as part of a statement to be displayed on the screen. Make sure you note the variable names to understand their purpose.

In each example the statements are to display the following output:

```
Minimum age to obtain licence:
18
Cost of drivers permit: 250.95
Class of vehicle licence: B
```

Example 2

Programming language: BASIC

```
REM example2
Dim age As Integer
Dim cost As Double
Dim grade As String
age = 18
cost = 250.95
class = 'B'
PRINT "Minimum age to obtain licence: "
PRINT age
PRINT "Cost of drivers permit: ", cost
PRINT "Class of vehicle licence: ", grade
```

Programming language: Pascal

```
Program example2;
var
    age: integer;
    cost: real;
    class: char;
Begin
    age := 18;
    cost := 250.95;
    grade := 'B';
    Write('Minimum age to obtain
    licence: ');
    Writeln('age');
    Writeln('Cost of drivers permit: ',
    cost);
    Writeln('Class of vehicle licence:',
    grade);
End.
```

Programming language: VBA

The cell locations A2, B2 and C2 in the spreadsheet in Figure 10.1 are referred to in the VBA programming code.

	A	B	C
1	Age	Cost	Class
2	18	250.95	B
3			

Fig 10.1 VBA Example 1

```
Private Sub CommandButton1_Click()
Dim age As Integer
Dim cost As Double
Dim class As String
     age = Range(“A2”).Value
     cost = Range(“B2”).Value
     grade = Range(“C2”).Value
MsgBox “ Minimum age to obtain licence:
“ & vbNewLine &
     MsgBox Range(“A2”).Value
     MsgBox “Cost of drivers permit: “ &
     Range(“B2”).Value
     MsgBox “Class of vehicle licence: “
     & Range(“C2”).Value
End Sub
```

These examples illustrate that different programming languages have slightly different syntax and data types. However, for the most part, variable declaration is straightforward. As the program requirements become more complex, so do the variable declarations.

Program statements

Program statements are the instructions which will carry out the requirements of the program. The following examples illustrate the use of conditional statements such as IF–THEN–ELSE. A variable *form* is defined and a value is assigned to it. A **conditional statement** then determines which message should be displayed.

Conditional statements

Example 3

Programming language: BASIC

```
form = 3
IF form = 3 THEN PRINT “Promoted to Form 3”
ELSE PRINT “Not promoted to Form 3”
```

Programming language: Pascal

```
Program Conditional;
Var form: integer;
Begin
     form := 3;
     If (form = 3)
     then writeln(‘Promoted to Form 3’)
     else writeln(‘Not promoted to Form
     3’);
End.
```

Programming language: VBA

```
Private Sub CommandButton1_Click()
Dim form As Integer, result As String
form = Range(“C3”).Value
     If form = 3 Then
     result = “Promoted to Form 3”
     Else
     result = “Not promoted to Form 3”
     End If
Range(“C4”).Value = result
MsgBox Range(“C4”).Value
End Sub
```

Looping

The following examples illustrate the use of looping constructs such as WHILE and FOR.

In each of the following examples, the code will output ‘IT for CXC’ 10 times.

WHILE loop

Example 4

Programming language: BASIC

```
line = 0
WHILE line < 10 DO
line = line + 1
PRINT "IT for CXC"
ENDWHILE
```

Programming language: Pascal

```
Program whileloop;
Var line: integer;
Begin
        line := 0;
        While (line < 10) Do
        Begin
             line := line + 1;
             Writeln('IT for CXC');
        end;
End.
```

Programming language: VBA

```
Private Sub CommandButton1_Click()
Dim row As Integer, line As String
row = 1
line = "IT for CXC"
Do While row <= 10
     MsgBox "IT for CXC"
     Cells(row, 2).Value = line
     row = row + 1
Loop
End Sub
```

FOR loop

Example 5

Programming language: BASIC

```
     FOR I = 1 to 10 DO
     PRINT "IT for CXC"
ENDFOR
```

Programming language: Pascal

```
Program forloop;
Var line: integer;
Begin
     for line := 1 to 10 do
     writeln('IT for CXC');
End.
```

Programming language: VBA

```
Private Sub CommandButton1_Click
Dim i As Integer
For i = 1 To 10
     MsgBox "IT for CXC"
Next i
End Sub
```

Questions

1. Explain the difference between syntax and semantics in a program.
2. What does it mean to declare a variable?
3. Why should you use meaningful variable names in your programs?

Usually, you will go through several steps before you can even type your program instructions, let alone view output from your program. At this stage, you are ready to see your program run. After you have typed your program using an editor it is called source code. Next, it needs to be tested for correctness. To do so, the source code must be translated into machine language called object code so that the CPU can carry out the program instructions.

From source code to object code

Converting a program from source code to object code is performed by a 'translator' program. Sometimes a program listing is shown, which is a printout or soft copy of the source program instructions as a reference while working with and coding the program.

These are programs that translate a specific program from one language to another – from a high-level language to a low-level language. Interpreters, compilers and assemblers are all translators.

An interpreter translates the source program line-by-line, and if an error is detected then translation is aborted (stopped) (Fig 10.2). If no errors are detected the interpreter instructs the control unit to execute the translated instruction. This cycle will be repeated for every instruction in the program. This is an easy but inefficient way of executing (running) programs not written in machine code. BASIC is a language which is interpreted.

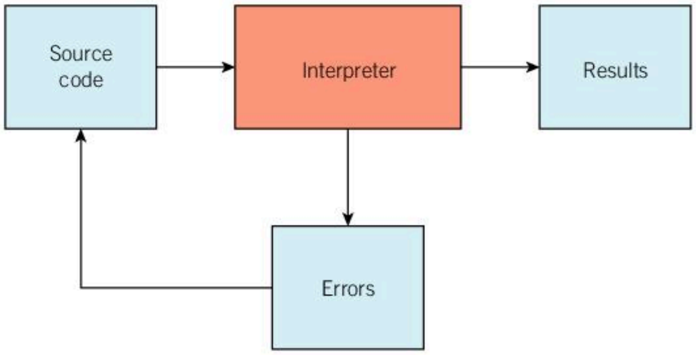


Fig 10.2 Illustration of the process of an interpreter

A compiler translates all program instructions at one time and produces a 'stand-alone' object program that can be executed (run) on its own (Fig 10.3). Error checks for syntax and logic errors are performed, and an error summary is issued (A). Once the program is compiled and no errors are detected, the compiler will then instruct the control unit to start executing the program. If the program produces incorrect output, or stops unexpectedly, then another type of error may be the cause (B). Otherwise, the object program will be executed each time it is run, but the source code only needs to be compiled once. If there are any modifications to the source code, then it must be recompiled. COBOL is a language which is compiled.

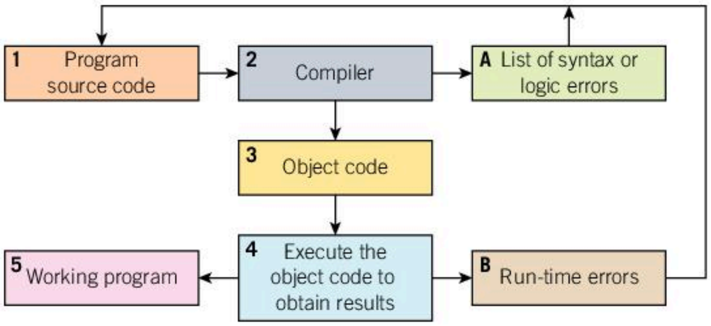


Fig 10.3 Illustration of the process of a compiler

Programming errors

Often, when the computer is compiling or interpreting your source code, an error, whether minor or major, will cause it to either output wrong results or not reach the stage of output at all. There are different types of errors which will cause your program to crash.

Syntax errors

Syntax errors occur when a mistake is made in the language rules or sentence structure of the programming language. Examples of syntax errors include misspelling of a variable or keyword. Syntax errors stop the program instructions or source code being converted to machine code. Tools used with the program usually detect syntax errors quite easily.

Examples of syntax errors

```
if (age 42) then     Incorrect syntax
print "OK"           since an operator
                     such as < or > is
                     missing
Bgin                 Spelling error in
For X = 1 to 5 Do    keyword BEGIN
End
```

Logic errors

Logic errors occur when a programmer makes mistakes in the sequence of the program sentences, such as using the wrong mathematical formula, wrong operator in an expression or incorrect use of looping structures. The program will usually compile; that is, the compiler will be able to convert it from source code to object code. Compilation with **logic errors** does not generate any syntax errors or warning messages, but when the program is run it produces the wrong results.

Example of a logic error

This segment of code will output 'A page' when x < 10:

```
IF (x < 10) THEN PRINT ("A page")
```

However, the programmer intended the statement to be:

```
IF (x > 10) THEN PRINT ("A page")
```

However, the error of putting the wrong symbol in the code means the output will be printed when x is less than 10 and not when it becomes greater than 10.

Debugging

Debugging is the process of finding the errors in the source code (detection), understanding why they occurred (diagnosis) and correcting them. Errors are often found through error messages generated by the program or the operating system, or because the program does not behave as expected.

Executing the program

If you have translated your program to object code without errors, you can now execute it and see the results. The final two terms commonly used with program execution are:

- program loading: copying a program from hard disk to the main memory in order to put the program in a ready-to-run state
- linking: combining various pieces of code and data together to form a single executable object code that can be loaded in memory. Linking can be done at compile time, at load time and also at run time.

Once your program compiles, you may either see your results on the screen, or you may see another type of error.

Runtime errors

Runtime errors occur as the program compiles or 'runs'. These errors are usually due to unexpected events such as division by zero or lack of memory for the computer to manipulate the data. Runtime errors can be very difficult to trace as the program may produce results most of the time.

Example of a runtime error

```
FOR average = 1 to 5 DO
    Results = results/(average – 1)
```

The program will produce an error message or cause the computer to 'freeze' when the value of average becomes 1.

The statement will be: results = results/(1 – 1)

… which is division by zero!

Questions

1 What is the name given to the printout or soft copy of the source program?

2 Explain the purpose of a translator and give three examples.

3 Explain why debugging is necessary.

Testing and debugging are necessary stages in the development cycle, and they are best incorporated early. Testing begins when you start to plan the program and continues until the program is completed and put into daily use. It is used to ensure that a computer application (program) is complete and does what it was meant to do.

Testing attempts to find problems in your code; debugging isolates and fixes the problems. Typically, when you test and debug your program, you need to ensure that it:

- runs without crashing or generating error messages that the end user may be unable to resolve
- carries out a reasonable action or produces error messages for a range of scenarios
- helps the user to continue or restart the program if unexpected user or system errors occur.

Errors can occur at any stage of a software application. They may happen frequently if you make errors while using the application, for example, but they also occur as a result of problems such as a power failure.

Testing cannot prove that your program is fully correct. It can certainly find defects (bugs) in the program, but there is no way to be sure that there are absolutely no errors in the logic of the program code. Therefore, the earlier a defect is found, the easier it is to fix it. Testing the program involves:

1. creating a set of test cases
2. running the program with each test case
3. checking that the performance of the software is as expected.

Test cases

A test case documents the values that are input and compares the predicted results with the actual results when a program is executed. When choosing test cases you must consider a range of values. It is important to ensure that every conditional branch, loop and statement of the program is actually tested by using a variety of test cases.

Black box testing (Fig 10.5) is used to check that the output of a module is as expected given certain inputs. The term 'black box' is used because the actual code being executed is not examined. The black box test provides no information about whether all statements or loops of the test module are actually necessary or not. Black box testing attempts to:

1. input values to the program
2. process the data
3. display the values returned from the program.

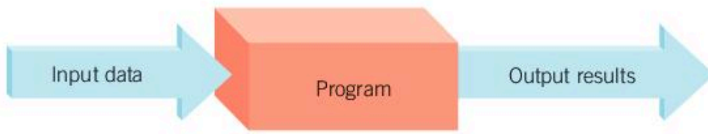


Fig 10.5 Black box testing checks the output from the values input

White box test cases (Fig 10.6) are designed to examine the inner structure of the program and are one of the most important test methods. The test checks the accuracy of the module from input, through every possible path through the test object, to the output.

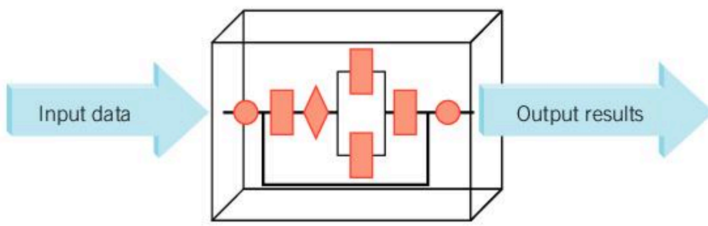


Fig 10.6 White box testing examines the inner structure of the module

Since testing every value is impractical, you should choose a range of values to check specific error conditions (Table 10.2). You should also be aware of which test data, if any, would be expected to produce errors.

Table 10.2 *Testing strings and numbers – examples of values to test*

Strings
Empty string
String consisting solely of white space
String with leading or trailing white space
Special characters such as -, #, ", ', & and <
'Foreign' characters typed on international keyboards
Numbers
No number (that is, leave input blank), if possible
Zero 0
Small and large positive numbers
Small and large negative numbers
Positive numbers out of required range
Negative numbers out of required range
Numbers with leading zeros such as 0034
Combinations of letters and numbers

Consider the program that gives a user access based on the correct username and password entered in the log-in screen (Fig 10.7).

Fig 10.7 Testing a username and password access screen

Examples of usernames and passwords as test cases can include combinations of values as shown below:

Test#	Username:	Password:
1	Admin	newday2019
2	01boss	Admin
3	00112233	newday2019
4	New day2019	Empty

Testing has to be planned. Some sections of the program often have to be tested before their completion, and this often includes testing of other subroutines with which they interact. The results of these tests determine the quality of the application. Although quality varies from system to system, some common attributes include:

- Reliability: This is the probability that the inputs to and use of the software will not cause it to crash for a specified time under certain conditions.
- Stability: A software system is stable or robust if an error in its operation does not result in irreversible damage to the application.
- Maintainability: This means how easy it is to debug, modify and expand the program at the appropriate locations without undesirable side effects.
- Usability: The software system should allow flexible input by the user. The results output should also be in a clear and well-structured form and be easy to interpret, and error messages must be provided in a form that the user can understand.
- Portability: This is the ease with which a software system designed for one type of computer can be adapted to run on different computers and operating systems.

Questions

1 Explain the difference between:
   a testing and debugging
   b black box and white box testing.

2 Give two examples of what should be done when testing a program.

3 List three attributes of a good program that has completed rigorous testing.

4 You have written a program to input two integers which will add these numbers and output the answer. Write examples of values that could be used to test the program.

Documentation is an important part of the software design process. Several types are produced during the process.

Documenting programming code

Documenting your code means typing short phases or comments describing what your code is doing. Comments placed alongside your programming code are useful if the program needs to be debugged or updated. If you write your code for your SBA and then review it a month later, you may spend some time trying to remember what some sections were supposed to achieve. Comments therefore help you and others to understand the purpose of your code, especially since your teacher or a moderator will be reviewing it.

Many students write their comments after the program is finished and working. If you leave the comments for later, you may not remember why you used a certain method, used different variables or used another set of code that doesn't resemble the requirements. Then you may resort to typing in comments that are similar to the code. This is not a good method.

Comments in programming code should include the following:

- An overview of the process and tasks, rather than rephrasing each step of your code.
- The name(s) of the authors of the program and even contact information for some programs.
- The date that the program was created or modified or reviewed. This provides a good guideline of how recently the program was updated.
- If you have finally found a solution to a part of the code that did not work, you should document what you did and include any comments that would help to explain that section of the code.

Adding comments to your programming code may seem like a tedious process. However, if you add them while writing your code, you may find that explaining the sections will help you understand more about programming.

Example 6 shows the listed programming languages with the keywords or symbols used for adding comments.

Example 6

Programming language: BASIC

```
REM Written by Ali James
    REM Apr 28, 2020
    REM ******************
    REM This program will output a
    single sentence
    REM ******************
```

Programming language: Pascal

```
{Written by Ali James          }
{Apr 28, 2020                  }
{******************            }
{This program will output a
single sentence                }
{******************            }
```

Visual Basic for Applications (VBA)

```
' Written by Ali James
' Apr 28, 2020
' ******************
' This program will output a single
sentence
' ******************
```

User documentation

User documentation is concerned with what the program does and how the end user makes the program do what it is supposed to do. It is usually the first contact they have with the system. It may give details of how to input data, how to format output (use the printer, save files and so on), how to access features of the program and how to interpret any system messages.

User documentation should be structured in such a way that it is not necessary to read it all before starting to use the application. It is usually integrated as part of online help, with lots of blogs and online chatrooms to share information on how to troubleshoot and use the system more efficiently. Five common components of user documentation are:

- a system overview which explains what the system can and cannot do
- an installation document, which explains how to install the system and tailor it for particular hardware configurations. The document suggests how to recover from errors and basic problems when things go wrong. It should include illustrations and examples
- an introductory manual which explains, in simple terms, how to get started with the system
- a reference manual, which describes in detail all the system facilities available to the user and how these facilities can be used. This manual assumes that the reader is familiar with the system and understands its concepts and terminology
- an optional system administrator's guide which explains how to react to situations which arise while the system is in use. It also carries out system housekeeping tasks such as making a system backup.

Questions

1. Give two reasons why documentation is important when designing an application.
2. Explain why should you include comments as you write your programming code.
3. State the keyword or symbol used to identify a comment in each of the following programs:
   - **a** Pascal
   - **b** VBA.
4. Describe the difference between program documentation and user documentation.
5. Explain two components of the following:
   - **a** program documentation
   - **b** user documentation.

Multiple choice questions

1 The part of the computer that interprets programming code in order to carry out the instructions of the program is the:
- **a** CU
- **b** CPU
- **c** ALU
- **d** ROM.

2 Errors resulting from incorrect use of programming language rules are called:
- **a** data
- **b** logic
- **c** syntax
- **d** runtime.

3 Using __________ data ensures that the program is working as expected.
- **a** correct
- **b** output
- **c** sample
- **d** source.

4 An example of a programming language that uses a graphical user interface is:
- **a** VBA
- **b** BASIC
- **c** COBOL
- **d** PROLOG.

5 A variable that stores a collection of characters such as a word, phrase or sentence is a(n):
- **a** string
- **b** integer
- **c** number
- **d** character.

6 Which of the following are true for FOR statements?
- **a** start value must be known
- **b** end value must be known
- **c** both start and end values are optional
- **d** both start and end values must be known.

7 Logic errors in a program can produce:
- **a** test data
- **b** syntax errors
- **c** wrong results
- **d** error messages.

8 Debugging is the process of finding errors in the:
- **a** test data
- **b** messages
- **c** source code
- **d** object code.

9 A test case documents the values that are __________ to compare them with the actual results when a program is __________.
- **a** input, compiled
- **b** input, executed
- **c** output, compiled
- **d** output, executed.

10 Adding comments to a program is best achieved:
- **a** when a user has tested it
- **b** while writing the program
- **c** after the program is written
- **d** when it is maintained in the future.

11 The keyword REM in BASIC refers to a(n):
- **a** error message
- **b** comment
- **c** data type
- **d** loop.

12 Testing a program involves each of the following, *except*:
- **a** creating a set of test cases
- **b** fixing errors in the program
- **c** running the program with each test case
- **d** checking the performance of the software.

Short answer questions

13 Consider the following samples of pseudocode:

Pseudocode_A	Pseudocode_B

<pre>Pseudocode_A: average of exam marks
using While loop
total = 0
count = 0
average = 0
OUTPUT 'Enter a mark'
INPUT mark
WHILE (mark is not equal to –1)
    total = total + mark
    count = count + 1
    OUTPUT 'Enter a mark'
    INPUT mark
ENDWHILE
IF count = 0
THEN DISPLAY 'No marks entered'
ELSE
    average = total/count
    DISPLAY average
END</pre>
	<pre>Pseudocode_B: average of exam marks
	using Repeat loop
	total = 0
	count = 0
	average = 0
	REPEAT
	    DISPLAY 'Enter mark'
	    INPUT mark
	    IF mark = –1
	    THEN DISPLAY 'End of marks'
	    ELSE
	        total = total + mark
	        count = count + 1
	UNTIL mark = –1
	IF count = 0
	THEN DISPLAY 'No marks entered'
	ELSE
	    average = total/count
	    OUTPUT average
	END</pre>

a For one or both samples, write suitable code with documentation using a programming language assigned by your teacher.

b Enter the following sample data to test the program. For each sample, explain whether you were able to enter all of the data and state the final results or errors, if any.

- **i** 23, 15, 18, A+, –10, –1, 14
- **ii** 23, 15, 18, –10, 14, –1, A+
- **iii** –1, 23, 15, 18, –10, 14, A+
- **iv** 23, 15, 18, 14, –1, A+

12 Consider the Training algorithm opposite that will accept information about the number of employees requiring training.

A country's code, name, company and number of employees to be trained are entered when prompted.

There is one trainer for every 40 employees. However, another trainer is needed if there are at least 15 or more employees over the requirement.

The program will calculate and print the number of trainers assigned.

Algorithm: Training

Declare variables code, numberofempl, trainers, extras as number
Declare country, company as literals/string
Prompt to enter a code
Accept code
Prompt to enter country
Accept country
Prompt to enter company
Accept company
Prompt to enter numberofempl
Accept numberofempl
Calculate number of trainers = numberofempl / 30
Calculate number of additional trainers (extras) from (numberofempl / 30)
If extras >= 15
Then trainers = trainers + 1
Output the number of trainers needed
End of algorithm

a Convert the following algorithm into code for a programming language approved by your teacher.

b Insert lines to appropriately document the program.

c Update the program to accept the information for six countries.

CHAPTER 11

PROGRAMMING WITH PASCAL

11.1 Introduction to Pascal

The programming language Pascal is used to teach introductory computer programming in many schools. This is because Pascal promotes a systematic, well-organised and logical approach to learning programming.

This chapter shows the practical aspects of implementing the programs introduced in Chapter 10. If this is your first programming language, you will need a few basics to get started. Think of a programming language as a recipe for baking a cake or instructions on building a bench. Pascal is one programming language, just as English is one spoken and written language.

Your mobile phone has a keypad that you use to type the number or text message. Then you click send and your call is made, or message sent, without the knowledge of how it is done. However, if you type a wrong digit when you are dialling a number, you will not be able to contact the correct person.

Similarly, a computer uses an application called a compiler to produce a result by translating the instructions in a program you write into a form the computer can interpret. If you type the wrong instructions, the compiler cannot produce any results. Instead it produces syntax errors or runtime errors.

Finding a Pascal compiler

There are a number of Pascal compilers available. In this chapter, Ezy Pascal is used. You should search online for 'Ezy Pascal Free Download' from Dolphin Bay Software.

Writing your first program

When you start Ezy Pascal, the Pascal editor will appear (Fig 11.1). The upper green area is to show the result of your programs, while the lower blue area is used for typing the program code.

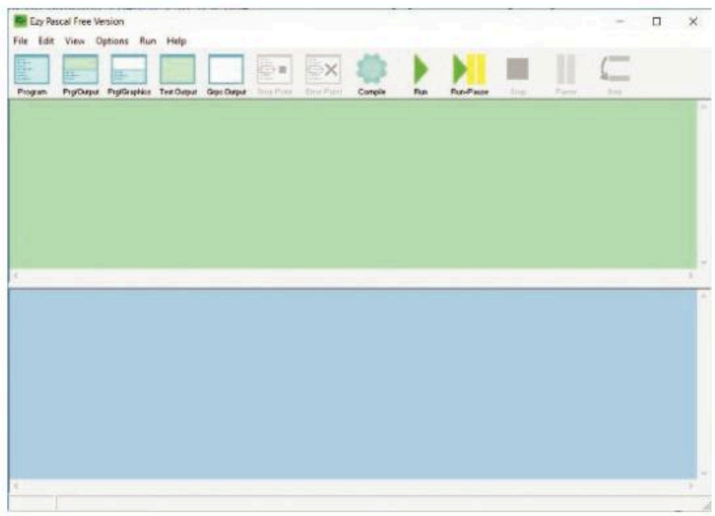


Fig 11.1 Ezy Pascal opening screen

In your Pascal editor, type the short Pascal program shown below. In the first line, be sure to type your name in place of 'type your name here' and today's date in place of type 'today's date here'.

```
{Name: type your name here}
{Title: My first simple program written
in Pascal}
{Purpose: To output one line}
{Date: type today's date here}
Program Sentence;
Begin
    Writeln('Hello to everyone');
End.
```

The word Program tells the Pascal compiler that this is the first line of code that contains the name of the program. In this example, the name of the program is Sentence.

The main section of a program starts at the word 'Begin' and finishes at 'End'. Within this section, the specific instructions that need to be executed by the compiler are included to solve our programming problem.

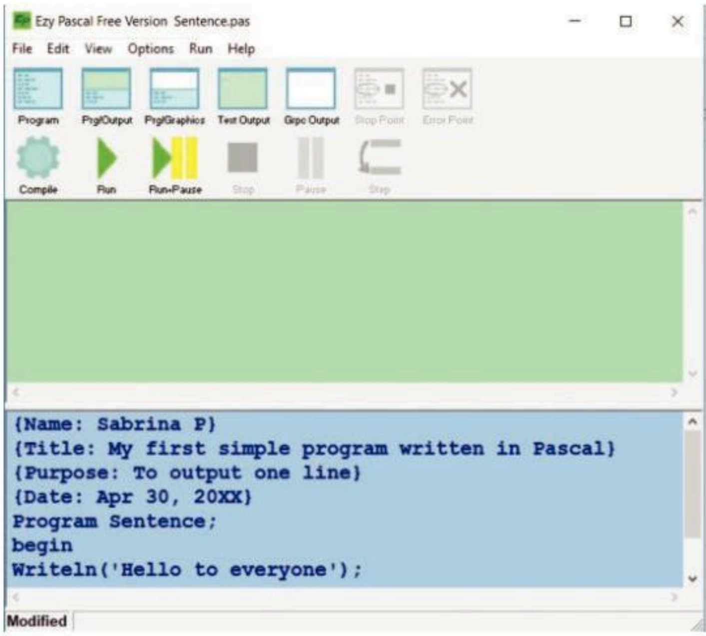


Fig 11.2 Typing Pascal code into the editor

Notice the first four lines of code. These are comments and are ignored by the Pascal compiler. You should always start your programs with the following comments:

- your name
- the title of the program
- a brief description of the purpose of the program
- the date the program was created.

Saving the program

You should save every program you type. To save the program, click File, Save. Browse to where you want to save your program (such as the Documents folder or a memory stick). Then type the name 'Sentence' as the name of the program. If the name of the program will be two or more words, then remove the spaces between the words. So, for example, 'One Sentence' will become 'OneSentence'. Pascal will add the default extension .pas to the program. You will see the name of the program above the EzyPascal menu (Fig 11.3).

Fig 11.3 Your program is given a name and shown at the top of the Ezy Pascal screen

Compiling the program

The Pascal compiler needs to convert the Pascal program from the statements you typed in the editor into machine language so that the central processing unit can execute the program correctly. The compiler first checks your program to ensure that no typing or syntax errors were made. Select Run, Compile or click the Compile icon on the menu. If you typed everything correctly, the compiler will output a message 'Compile successful' at the bottom of the screen (Fig 11.4). Otherwise an error message will be displayed (also at the bottom of the screen) and a possible location of the error will be highlighted on a line of code.

Fig 11.4 Compiling the program shows a message at the bottom of the screen that there were no syntax errors

In Figure 11.5, the compiler has highlighted the line immediately below the error. The orange arrow shows where the error is located: the semicolon was omitted at the end of the line.

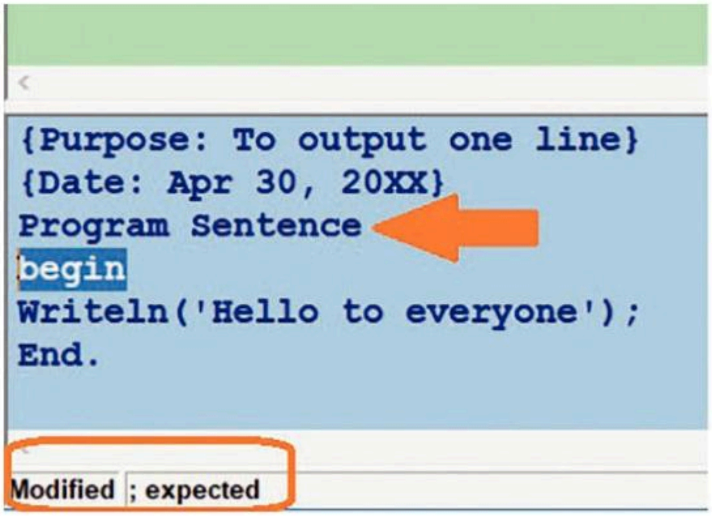


Fig 11.5 The compiler has highlighted the line immediately below the error

When compiling and removing errors, if you make multiple corrections, and more errors appear, then you may not know which correction caused the additional errors. Therefore, it is best to make corrections in this order:

1. Identify and correct each error individually.
2. Save the program.
3. Compile the program again.

You should continue to compile the program until there are no errors and the 'Compilation successful' message is shown.

Running the program

Once you have no compilation errors, you can execute (run) the program to see if it produces the correct output. From the Run menu, select the Run option or click the Run icon. The program will execute in a program as shown in Figure 11.6.

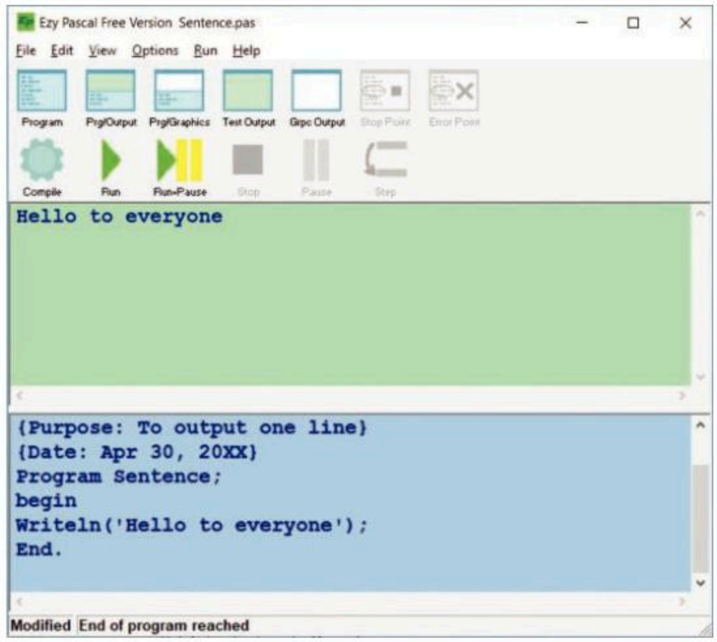


Fig 11.6 The output of the program named Sentence

Questions

1 State which of the following are valid names for a Pascal program:

- **a** Add numbers
- **b** 10Lines
- **c** For Loop
- **d** ThreeChoices
- **e** maxValues

2 List three steps to follow when compiling a program.

Congratulations! Now that you have completed your first Pascal program, you should compile and execute it to see your results. Table 11.1 shows the basic structure of a Pascal program.

Table 11.1 *Structure of Pascal program*

	Example(s)	**Explanation**
Program header		
Program *name*;	Program Sample; *For Ezy Pascal* Or Program Sample (input, output); *For some other compilers*	All Pascal programs must have a **Program** heading. The first word, Program, is compulsory.
Declarations		
Const	Const pi = 3.14;	Const is short for constant. You **assign** a **value** to a constant when you create it.
Var	Var Mark, Count: integer; Test: real; Grade: char; Title = 'Hello';	Var is short for variable. Before you can use a **variable**, you must first **declare** it. These examples declare Mark and Count as integer, Test as real and Grade as character. Variable types include integer, real, character and literal (string).
Procedures and functions		
Begin	Begin	Denotes the start of one or more programming statements
Statements		
	Read(Mark); Writeln('Thank You'); If (Mark > 30) Then Grade := 'P' Else Grade := 'F';	These include: input, output, conditional (IF–THEN–ELSE) assignment.

	For count := 1 to 5 Do
	Begin
	Test := Mark * count;
	Writeln('The test output is ', test);
	End;
		For loop
		Begin (of a compound statement)
		compound statements have two or more consecutive statements
		End; (of a compound statement)

	While Mark > 30 Do
	Begin
	Writeln('This is a sample while loop');
	Writeln('More statements can go here')
	End;
		While loop
		
		Can include compound statements enclosed in Begin and End

	Repeat Writeln('this is a sample Repeat loop'); Writeln('More statements can go here') Until Mark > 30;	Repeat loop Can include compound statements that may not need Begin and End
End.	End.	**End**. (with a full stop) indicates the very last line or end of the program.

Punctuation

The semicolon is used to separate declarations and most statements. Many Pascal programs are written to follow a structure, such as those in previous examples. However, since the semicolon separates the individual declarations and statements, the following Pascal program will also compile and run:

```
Program Sentence; Begin Writeln('Hello
to everyone'); End.
```

The keywords 'Begin' and 'End' act as brackets for multiple statements, so there is no semicolon after begin but usually after End to show the end of the statements. There are some occasions when no semicolon is used after End, as in the following example:

```
If (line >80)
Then   Begin {perform the following two
       statements}
       Writeln('This is over the line');
       Newline := Newline – line;
End                         no semicolon
Else Writeln('This is within the
line', Newline);
```

If a semicolon is placed with the End, this would cause a syntax error for the IF–THEN–ELSE statement.

The last line of every Pascal program's code must be 'End.' The full stop denotes the end of the program. Comments in { } can however be written after this last statement.

Statements in Pascal

Statements give instructions to the computer. A simple statement is a single instruction while a compound statement comprises two or more statements that are within 'Begin' and 'End' keywords. A compound statement is useful if you need to perform some instructions in sequence or repetitively before moving on to the next set of statements. Various types of statements are explained in Table 11.2.

Table 11.2 *Types of statements*

Statement	Example	Explanation
Input statement	Read;	The cursor stays next to the text entered
Read and Readln reads data from keyboard, and waits for the *Enter* key on the keyboard to be pressed	Readln;	The cursor moves to the next line after the text is entered
Assignment statement Places data in a variable	Mark := 30;	:= is called the assignment operator The variable is on the left of the assignment operator The value is on the right of the assignment operator The semicolon (;) ends the statement Here, Mark is assigned the value 30
Output statement Shows the output on the monitor screen	Write;	The cursor remains at the same place on the screen
	Writeln;	The cursor goes to the start of the next line
	Write(Mark);	Outputs 30
	Writeln(Mark);	Outputs 30 | (| is the cursor)
	Write('Score of',Mark);	Outputs Score of 30 |
	Writeln('Score of',Mark);	Outputs Score of 30 | (| is the cursor)

Compound statement	Begin
	Mark :5 Mark 1 5;
	Writeln(Mark);
	End;
		Begin (of a compound statement)
		Two or more consecutive statements
		End; (of a compound statement)

Questions

1 Explain the difference between:
   - **a** a compound statement and a single statement
   - **b** write and writeln
   - **c** := and =

2 Consider these two fragments of Pascal code:

Fragment 1

```
If (line > 80)
Then Writeln('Extra line');
Newline := Newline – line;
Writeln('Same line ',Newline);
```

Fragment 2

```
If (line > 80)
Then Begin
    Writeln('Extra line');
    Newline := Newline – line;
    End
Else Writeln('Same line ',Newline);
```

a Determine the output if the values for the variable line were initialised to:
   - **i** line := 85
   - **ii** line := 55

b Convert Fragment 1 into a Pascal program. Initialise line to any value and Newline to 85. Compile and run the program.
   - **i** Initialise the value for the variable line to 85 and run the program again. Note the results.
   - **ii** Change the value for the variable line to 55 and run the program again. Note the results.

c Repeat part b for Fragment 2. Compare the results of both programs.

Sometimes the output of a Pascal program is just what you expected. There are times however, when you need to look at your code again to see what is missing, has errors, or is not set out in logical steps. The following sample programs illustrate various results. Type the program in Example 1 into your Pascal editor. Try to maintain the indentation of the code, then compile and run it. If you typed it correctly, your output should look like the result given below.

Example 1

```
Program Bigger;
Var
    num1, num2: integer;
Begin
    Write('Enter two integers ');
End.
```

The result is:

```
Enter two integers |
```

The vertical bar '|' in the output represents the cursor. Notice where it is located.

For now, you cannot enter any data, since the program did not have any input statements. Modify the program code to change the output statement as follows:

```
Write('Enter two integers ');
```

to

```
Writeln('Enter two integers ');
```

Compile and run the program again. Where is the cursor now?

The result is:

```
Enter two integers
|
```

Suppose you were to output statements that combine numbers or text. Update your program once again (as in Example 2) to include input and output statements.

Example 2

```
Program Bigger;
var
num1, num2: integer;
Begin
    Write('Enter two integers ');
Readln(num1,num2);
    Writeln('You entered ',num1,' and
    ', num2');
End.
```

When you run this program, type the number 3, then press the *Spacebar*, then type the second number 56, then press the *Enter* key. The program ends there.

The result is:

```
Enter two integers: 3 56
You entered 3 and 56
```

Dividing two numbers

Adding, subtracting and multiplying integers and real numbers in a Pascal program involves assignment statements. However, division is slightly different if the numbers are integers or real numbers. Try compiling and running the following two programs:

Example 3

```
Program Int_division;
Var int1, int2, result : integer;
Begin
     int1 := 10;
     int2 := 2;
     result := int1 div int2;
     Writeln(int1, ' divided by ',int2,
     'equals ',result);
End.
```

Your result should be similar to this:

```
10 divided by 2 equals 5
```

Example 4

```
Program Real_division;
Var realA, realB, result : real;
Begin
     realA:=10;
     realB:=2;
     result := realA div realB;
     Writeln(realA, ' divided by
     ',realB,' equals ',result);
End.
```

This time, your answer is not quite what you expected. It may look like:

```
1.00000000000000000E+0001 divided
by 2.00000000000000000E+0000 equals
5.00000000000000000E+0000
```

You need to apply the formatting feature to produce more user-friendly output. Example 5 has now been modified from the version in Example 4 by formatting the output of the numbers.

Example 5

```
Program Real_division_2;
Var realA, realB, result : real;
Begin
     realA := 10;
     realB := 2;
     result := realA div realB;
     Write(realA:2:2, ' divided
     by ',realB:2:2, ' equals
     ',Result:2:2);
End.
```

The result now looks like:

```
10.00 divided by 2.00 equals 5.00
```

Questions

Convert each of the following sets of pseudocode to a Pascal program. Be sure to:

- include comments in the program
- declare all variables
- include appropriate indentation.

1

```
Algorithm Calculate_age
INPUT thisyear
INPUT birthyear
age = thisyear – birthyear
IF age < 13
THEN OUTPUT "Millee is a teen"
ELSE OUTPUT "Millee is not a teen"
ENDIF
```

2

```
number = 1
WHILE (number <= 3) DO
BEGIN
     number = number + 1
     Output "the number is", number
ENDWHILE
OUTPUT "out of loop"
```

3

```
age = integer
FOR age = 13 to 19 DO
     Output "You are a teenager"
ENDFOR
```

4

```
Pseudocode: average_of_exam_marks
total = 0
count = 0
average = 0
REPEAT
      DISPLAY 'Enter mark'
      INPUT mark
      IF mark = -1
      THEN DISPLAY 'End of marks'
      ELSE
        total = total + mark
        count = count + 1
UNTIL mark = -1
IF    count = 0
THEN  DISPLAY 'No marks entered'
ELSE
      average = total/count
      OUTPUT average
END
```

CHAPTER 12

PROGRAMMING WITH VISUAL BASIC FOR APPLICATIONS

12.1 Introduction to Visual Basic for Applications

Visual Basic for Applications (VBA) is part of Microsoft's programming language. You can write customised programming code in Access, Excel and Word to complement their built-in functions. Each application also has the built-in Visual Basic Editor. If you use any of these applications for your School-Based Assessment (SBA), then you will not need to submit additional files for the programming component since it is included in the file. Microsoft Excel will be used to illustrate the programming examples in this chapter.

There are two ways to write Excel VBA code. Either place a Command Button on the spreadsheet to access the code or write VBA code within the editor.

The following steps summarise one way to access the editor in Microsoft Excel, and how to write programs using VBA code:

1 Add the Developer tab if it is not visible.
2 Place a Command Button on the spreadsheet.
3 Change the name of the Command Button to an appropriate name.
4 Type the VBA code into the editor and set up the spreadsheet.

Test your program by clicking on the Command Button. You can also bring up the VBA editor by pressing *Alt + F11*.

Adding the Developer tab

Once you have added the Developer tab in an application, the editor becomes available to write your code and output your results. To add the Developer tab in earlier versions of Excel (such as 2007):

1 Click on the Office button (top-left corner of the screen)
2 Select Excel Options, in lower-right corner of the Option box.
3 Select the Popular tab on the left and check the Show Developer tab in the Ribbon option (Fig 12.1).

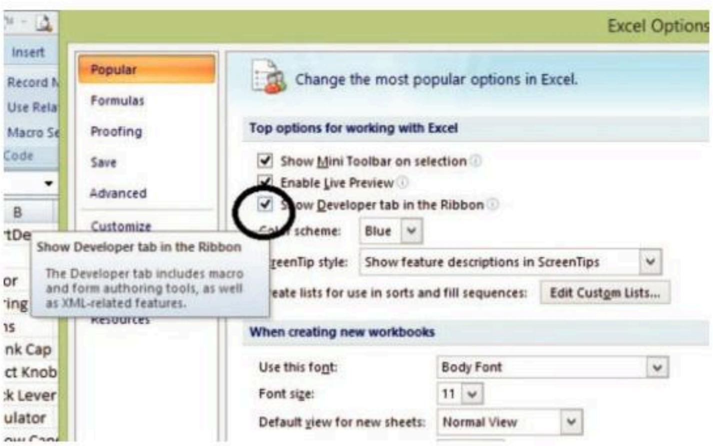


Fig 12.1 Adding the Developer tab in Microsoft Excel 2007

To add the Developer tab in later versions of Excel, such as (2013 and 2016):

1 Right-click anywhere on the ribbon, and then click Customize the Ribbon (Fig 12.2).
2 Under Customize the Ribbon, on the right side of the dialogue box, select Main tabs (if necessary).
3 Tick the Developer check box (Fig 12.3). Click OK.

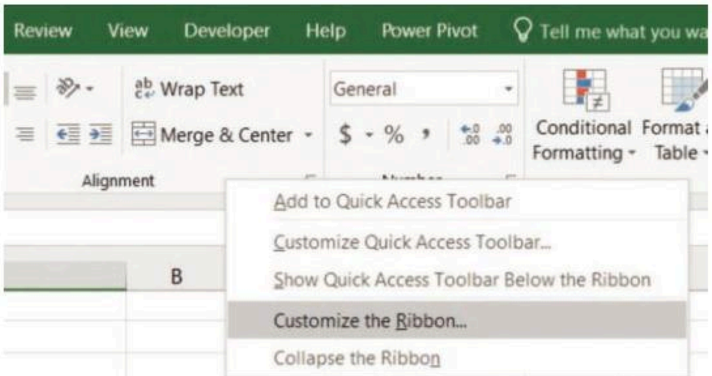


Fig 12.2 Right-click on the ribbon and select Customize the Ribbon

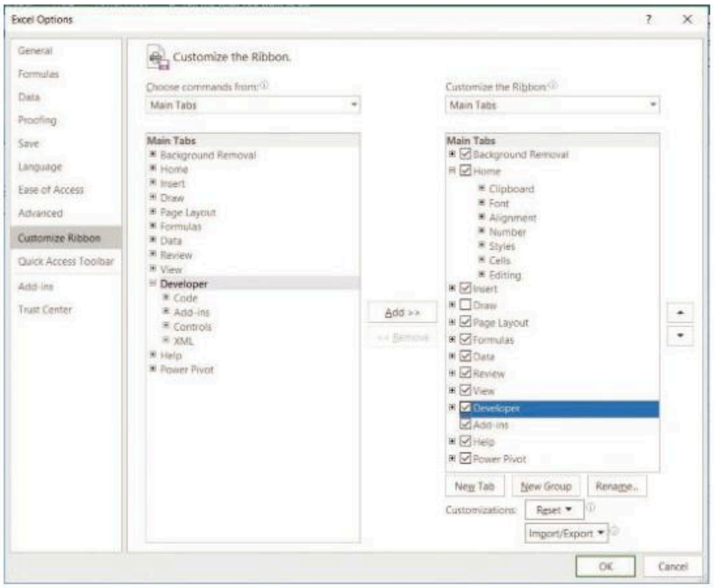


Fig 12.3 Check the option to Add the Developer tab

The Command Button

The **Command Button** is similar to the Submit, OK, Cancel and Close buttons that you would use to close a form or dialogue box. It is used to execute code in the Visual Basic editor.

To place a Command Button on your worksheet, use the following steps.

1 Click the Developer tab, then click the Insert button.
2 In the ActiveX Controls group, click the Command Button icon (Fig 12.4).
3 Click on the worksheet or drag to create the rectangle that will be the Command Button on your worksheet (Fig 12.5).

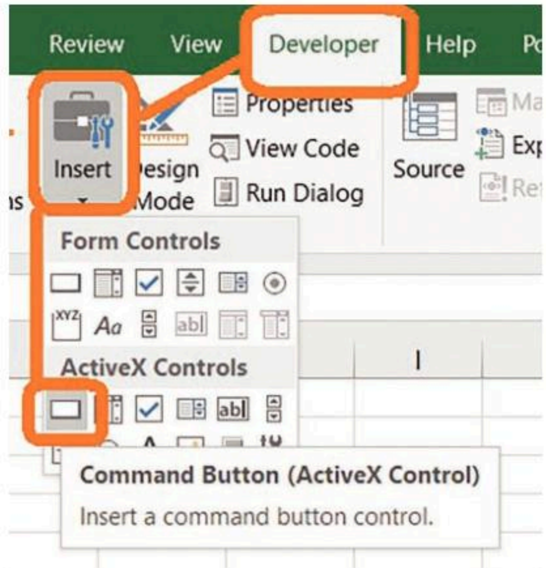


Fig 12.4 Locating the Command Button on the Developer tab

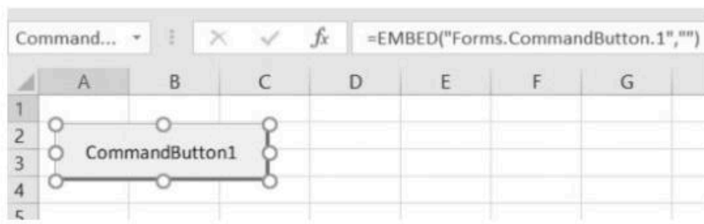


Fig 12.5 Inserting a Command Button on the worksheet

If you wish to move the Command Button to another location:

1 Click on Design Mode to select it, then click on the Command Button.
2 Once the button shows circles at the edges, you can drag it or cut and paste it in another location.

As you create more Command Buttons on the sheet, the number for the Command Button increases from **CommandButton1** to **CommandButton2** and so on.

Using the VBA editor

Once your Command Button has been placed on the worksheet, you can now add your VBA code:

1 Right-click on the CommandButton1 icon. Note that the Design Mode icon on the ribbon should be selected.

2 Click View Code. The Visual Basic editor appears (Fig 12.6).

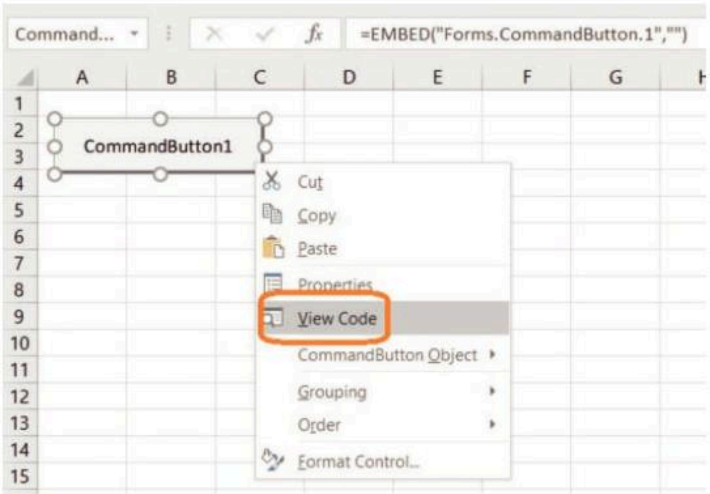


Fig 12.6 Getting ready to add code to your Command Button

3 Place your cursor between the Private Sub CommandButton1_Click() and End Sub lines. Your code should always be typed between these two lines.

4 As your first example, type the code shown below:

```
MsgBox "This is my first message in VBA!"
```

Edit the Command Button

In the VBA editor window (Fig 12.7), to rename the Command Button make sure the Properties window is visible. If it is not, then click View in the menu and select Properties window.

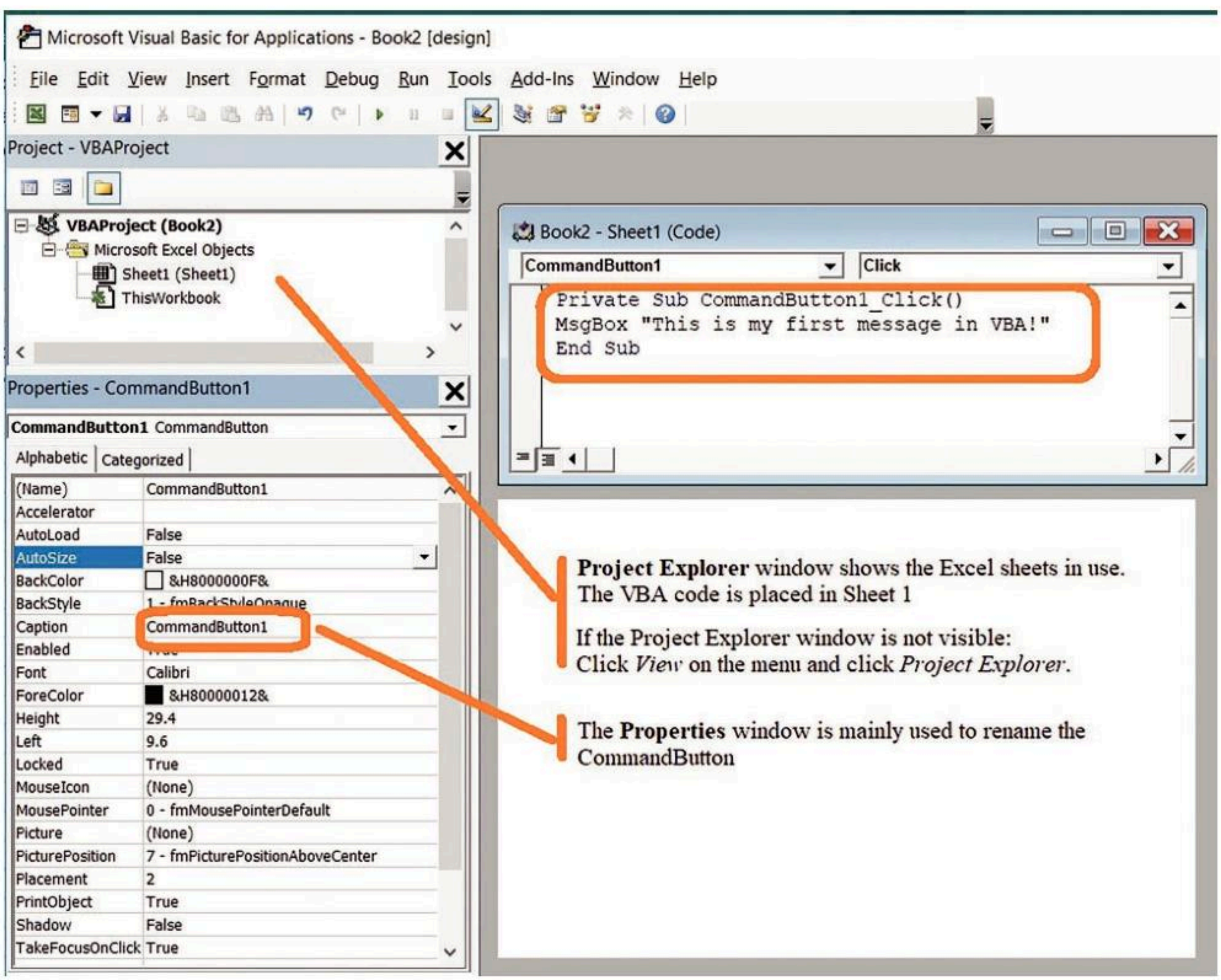


Fig 12.7 The Visual Basic editor where programs are typed and edited

You can use the Properties window to make the following changes to CommandButton1:

1 Click the caption option to change the name from CommandButton1 to Click Here.
2 Click the Font option to the type and size of the font to Calibri 14 point and bold. You can access this by clicking the box with three dots to the right of the font name.

As you create another set of code in the same sheet, add another Command Button. A sheet can therefore have many Command Buttons each for a different task. Each Command Button will also be numbered so that you can differentiate among them. Alternatively, you can rename them so that they relate to the purpose of their tasks.

Testing your program

First you need to close the Visual Basic editor:

- Select File and click Close and Return to Microsoft Excel.
- Alternatively, you can switch to the Excel sheet by clicking the Excel icon under the File menu option in the editor.

Once you are in the spreadsheet:

1 Make sure Design Mode is deselected by clicking on it.
2 Then click the Command Button on the sheet.

You should see results on the screen. Figure 12.8 shows the message that should be displayed.

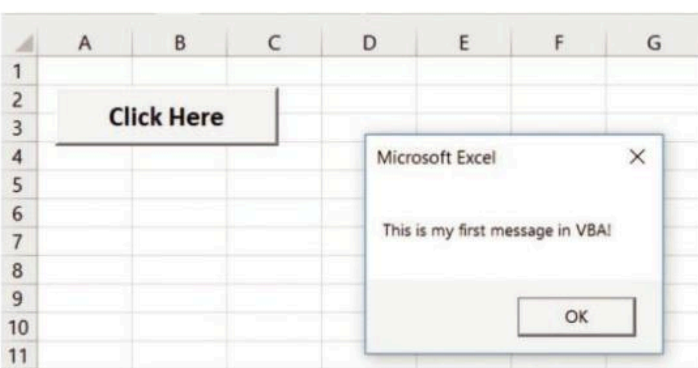


Fig 12.8 Clicking the Command Button shows the result

Saving the program

Your code is part of your Excel worksheet so there is no need to save it as another file. However, you will need to save your workbook as a Macro-Enabled Workbook. In the Save As dialogue box, use the drop-down menu to do this.

Correcting errors

Sometimes the program will display error messages and not produce output as expected. The VBA editor highlights the text to indicate that an error occurs after that point. It also shows the line and column number of the location of the error. Figure 12.9 shows that the error is found on line 2, column 7. The error in this code is that a single quote was used instead of a double quote.

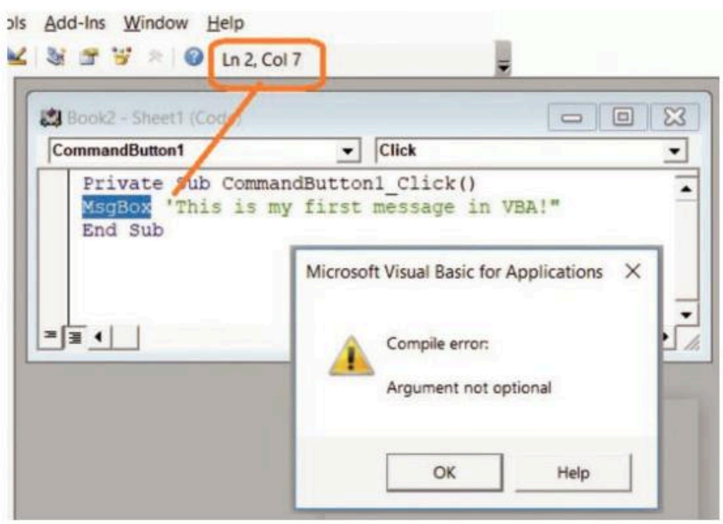


Fig 12.9 The VBA editor highlights the text to indicate that an error occurs after that point

Questions

1 What must be done to access the VBA editor?
2 Give two examples of names that can be used for Command Buttons.
3 What is the name of the controls group where the Command Button icon is found?
4 What must be done to the Command Button before running the VBA code?
5 How are Excel sheets with VBA code saved?

Congratulations! Now that you have written your first VBA code, let's show how it can be used with your worksheet and SBA. Since you may be using data from your Excel sheet to create VBA code, this section will provide some examples of statements, variables, conditional and loop control structures. Remember that all code is written between the Private Sub CommandButton1_Click() and the End Sub lines that are found in the code window editor.

Declaring variables and data types

A VBA variable must be less than 255 characters, contain no spaces or special characters and not begin with a number. Each variable must have a data type. The main data types that you may want to use for your SBA are shown in Table 12.1.

Table 12.1 *VBA data types*

Numeric data types	Non-numeric data types
Integer	String (characters)
Double (for real numbers)	Date
Currency	Boolean (true or false)

The syntax to declare a variable is:
Dim variableName as DataType.

Note that the following three lines:

```
Dim mark As Integer
Dim cost As Double
Dim exam As Date
```

can also be written on one line as:

```
Dim mark As Integer, cost As Double,
exam As Date
```

Statements

Remember to include comments in your code. These are denoted by a single quote at the start of a statement. The following statements are quite useful when working with data on your spreadsheet. As you write your code, you may notice that the editor sometimes adjusts the names of the variables to start with capital letters, indents some lines of code, and even changes the colour of some of the various parts of the syntax such as green for comments and dark blue for keywords in your code. Table 12.2 shows some examples of VBA statements.

Table 12.2 *Useful VBA statements*

```
Private Sub CommandButton1_Click()
```
Must be the first line of code when using a Command Button

```
'This is a comment
```
Remember to use comments in your code

```
Range("cell address").Value
```
This statement accesses data in a cell

```
Range("C4").Value = info
```
Places data from the variable named *info* into cell C4

```
info = Range("B3").Value
```
Places data from cell B3 into a variable named *info*

```
Worksheets(1).Rows(1).Select
```
Selects row 1 in the current worksheet

```
Worksheets(1).Columns(3).Select
```
Selects column 3 or Column C

```
Worksheets(1).Cells(1,1).Select
```
Selects cell A1

```
Selection.Copy
```
Then copies the data in cell A1

```
Worksheets(1).Cells(2,1).Select
```
Selects cell B1

```
ActiveSheet.Paste
```
Pastes data in cell B1

```
End Sub
```
Must be the last line of code

Displaying information

The MsgBox and InputBox are two keywords that display messages or information via a dialogue box.

```
MsgBox "text message" displays 'text
message' in a dialogue box.
MsgBox Range("B3").Value displays the
data stored in cell B3 in a dialogue box.
```

Unlike MsgBox, the InputBox keyword requires a variable to which it can return the results. Consider the two statements below that use the InputBox keyword. The variable year must be declared as an Integer data type.

year = InputBox("Enter a Year", "Information Required") shows a prompt in a dialogue box that waits for the user to input text to an empty area or click a button, and then outputs the contents of the text box to the screen (Fig 12.10).

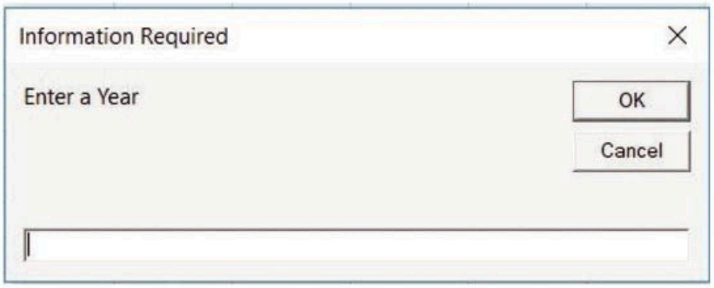


Fig 12.10 The InputBox displays a prompt in a dialogue box and waits for the user to input text or click a button

Note the slight variation in the following Inputbox statement:

year = InputBox("Enter a Year", "Information Required", 2019) shows the default number 2019 in the input area.

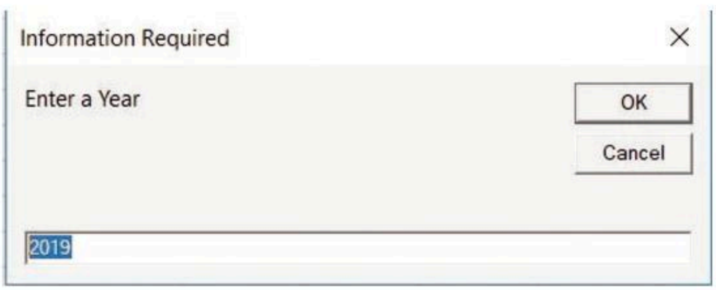


Fig 12.11 A default value can be part of the dialogue box

Remember to save your workbook as a Macro-Enabled Workbook.

Conditional statements

The following examples illustrate the use of the IF–THEN and IF–THEN–ELSE statements.

IF–THEN

In Example 1, the code places a message in a cell based on the value found in cell C3. Notice that no message is displayed if a value of 50 or less is found in the cell (Fig 12.12).

Example 1

```
Private Sub CommandButton1_Click()
```
First line of code

```
Dim score As Integer, result As String
```
Two variables are declared

```
score = Range("C3").Value
```
value in cell C3 is placed in variable *score*

```
If score > 50 Then result = "Good!"
```
if *score* is greater than 50 message is placed in variable named *result*

```
Range("C4").Value = result
```
message is pasted in cell C4

```
End Sub
```
Last line of code

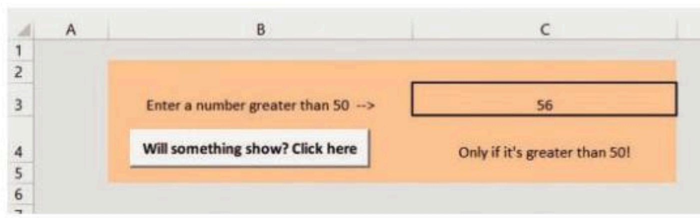


Fig 12.12 Example of the IF-THEN statement

IF–THEN–ELSE

In Example 2, a different message is placed in cell J15, based on the value found in cell J8 (Fig 12.13).

Example 2

```
Private Sub CommandButton1_Click()
```
First line of code

```
Dim eligible As Integer, result As String
```
Declare two variables

```
eligible = Range("J8").Value
```
Value is cell J8 is placed in *eligible*

```
If eligible >= 5 Then
```
If the value in *eligible* is >= 5,

```
result = "Yes!"
```
Then place message 'Yes' in variable *result*

```
Else:
```
Otherwise

```
result = "Sorry!"
```
Place another message in variable *result*

```
End If
```
End of the IF–THEN–ELSE statements
```
Range("J15").Value = result
```
Place message in cell J15
```
End Sub
```
Last line of code

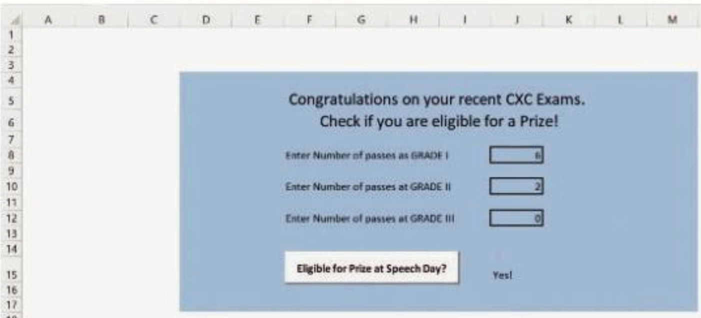


Fig 12.13 Example of the IF–THEN–ELSE statement

Nested IF-THEN-ELSE (CASE)

The code in Example 3 determines whether the discount on the amount of sales entered in cell G10 is 0%, 5%, 10% or 15%. The discount amount is placed in cell G12 and the amount due is calculated and placed in cell (Fig 12.14). The Case statement is used since it can become confusing with too many IF–THEN–ELSE statements. The syntax for the Case statement is:

```
Select Case Condition
Case value_1
     Code when Condition = value_1
Case value_2
     Code when Condition = value_2
Case value_3
     Code when Condition = value_3
Case Else
     Code to execute when all the other
cases are False
End Select
```

Example 3

```
Private Sub CommandButton1_Click()
```
```
Dim saleamt, disc As Double
```
Declare two variables
```
saleamt =
```
Round (Range ("G10") .Value

Place the integer value from G10 and place in saleamt
```
Select Case saleamt
```
Start of Case statement
```
Case Is >= 3000
```
If value is >= 3000
```
disc = 0.15
```
Assign 15% to the discount
```
Case Is >= 2000
```
If value is >= 2000
```
disc = 0.1
```
Assign 10% to the discount
```
Case Is >= 1000
```
If value is >=13000
```
disc = 0.05
```
Assign 5% to the discount
```
Case Else
```
Otherwise
```
disc = 0
```
No discount
```
End Select
```
End of case statement
```
Range("G12").Value = disc
```
Place discount in cell G12
```
Range("G15").Value = (1 - disc)*saleamt
```
Calculate the amount due and place in cell G15
```
End Sub
```

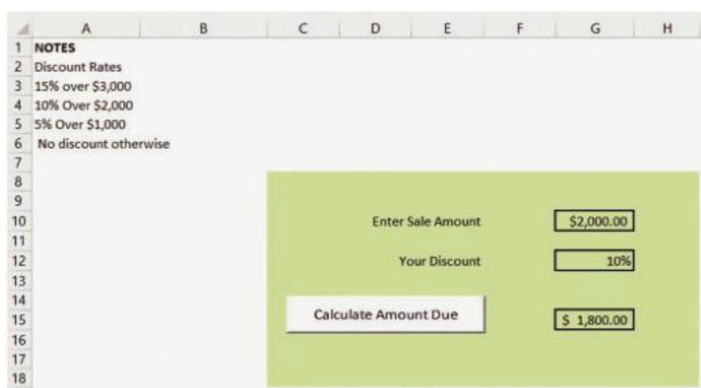


Fig 12.14 Example of using a Case statement

Loops

You can use a single loop to cycle through a one-dimensional range of cells. This means one row or one column.

Example 4 is used to calculate the updated cost of a list of items after a 10% discount is applied. The code works as follows:

- The While loop starts from row 2, column 2 (cell B2).
- Checks if it is a blank cell, which is denoted by “” (contains ‘Shirt’ for the first cycle).
- It takes the value in row 2 column 2 (cell B2), which is the cost of the item and calculates 90% of the cost. This is the same as calculating 10% of the item and then subtracting it from the cost. The updated cost is placed in the same row but in column 3.
- Cycles to the next row in column 2 (or column B) by adding one to the variable row.
- Returns to the top of the loop to check if the cell for the items is empty. Takes the cost for row 3, column 2 which is the blouse, and goes through the loop again.

Example 4

```
Private Sub CommandButton1_Click()
```

```
Dim cost As Double
```

Declare variable cost

```
cost = 2
```

Start at the first item in the list (Shirt)

```
Do While Cells(cost, 2) <> ""
```

The While cell is not empty

```
Cells(cost, 3).Value = Cells(cost,
2).Value * 0.9
```

Calculate 90% of the value and place it in the next column

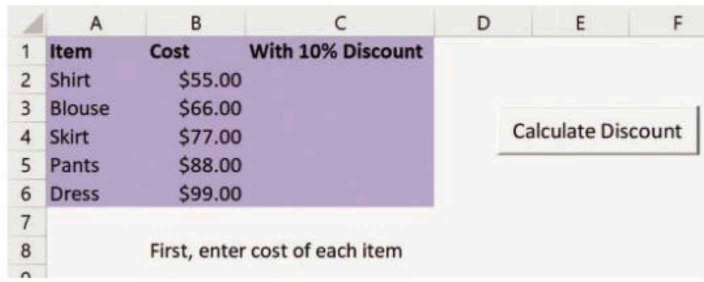
```
cost = cost + 1
```

Go to the next row

```
Loop
```

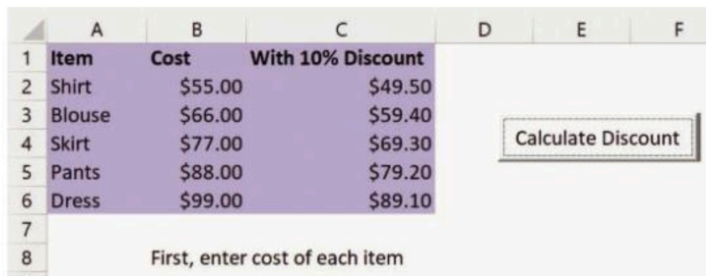
Return to Do While

```
End Sub
```



	A	B	C	D	E	F
1	Item	Cost	With 10% Discount			
2	Shirt	$55.00				
3	Blouse	$66.00				
4	Skirt	$77.00				
5	Pants	$88.00				
6	Dress	$99.00				
7						
8		First, enter cost of each item				

Fig 12.15 Example of loop before the Command Button is clicked



	A	B	C	D	E	F
1	Item	Cost	With 10% Discount			
2	Shirt	$55.00	$49.50			
3	Blouse	$66.00	$59.40			
4	Skirt	$77.00	$69.30			
5	Pants	$88.00	$79.20			
6	Dress	$99.00	$89.10			
7						
8		First, enter cost of each item				

Fig 12.16 Example of loop after the Command Button is clicked

Questions

1 Create a Command Button that will display your name in a dialogue box when clicked.

2 Create a Command Button that, when clicked, will display a message if the data stored in cell D5 is equal to 10.

3 Modify the code in Example 2 as follows:
- if there are more than 4 passes at Grade II, then output 'Well done'
- if there are fewer than 3 passes at Grade III, then output "Good work"
- add the number of passes for all grades. If the number is greater than 6, then output 'Prize and Plaque'.

4 Use the Case statement to output whether a student is at primary, secondary or tertiary level based on the age entered.

5 Calculate the updated cost of a list of five drinks after a 15% tax is applied.

6 Convert each of the following sets of pseudocode to VBA code. Be sure to:
- include comments in the program
- declare all variables
- place the data in separate cells
- include appropriate indentation.

a

```
Pseudocode: calculate_age
Input thisyear
Input birthyear
age = thisyear - birthyear
IF age < 13
THEN output "Millee is a teen"
ELSE output "Millee is not a teen"
ENDIF
```

b

```
Pseudocode: output numbers
number = 1
WHILE (number <= 3) DO
BEGIN
      number = number + 1
      Output "the number is", number
ENDWHILE
Output "out of loop"
```

c

```
Pseudocode: determine whether
a teenager
age = integer
FOR age = 13 to 19 DO
Output "You are a teenager"
ENDFOR
```

d

```
Pseudocode: average of exam marks
total = 0
count = 0
average = 0
OUTPUT 'Enter a mark'
INPUT mark
WHILE (mark is not equal to -1)
      total = total + mark
      count = count + 1
      OUTPUT 'Enter a mark'
      INPUT mark
ENDWHILE
IF count = 0
THEN DISPLAY 'No marks entered'
ELSE
      Average = total/count
      DISPLAY average
END
```

7 Consider the following VBA code:

```
Private Sub CommandButton1_
Click()
Dim amount As Double
Dim interest As Double
Dim years As Integer
Dim payment As Double
amount = (Range("C2").Value)
interest = Range("C3").Value
years = Range("C4").Value
payment = PMT(interest / 12,
years * 12, -amount)
Range("C5").Value = payment
End Sub
```

a List the names of the variables in the code.

b List the cells that are used to store data in a spreadsheet.

c State the name of the Excel function that is used in this code.

d You now wish to borrow $50,000.00 and repay at 8.5% per annum for 7 years. Copy the grid of cells and use the code in C to write the data in the appropriate cells.

	A	B	C	D
1				
2				
3				
4				
5				

Appendix 1

Information Technology School-Based Assessment guidelines

The Information Technology (IT) School-Based Assessment (SBA) comprises an integrated project requiring the use of database, spreadsheet and word-processing software. It also involves the design of a web page using free online web page software or word-processing software. It is expected that data will be exported among most or all of these applications. The SBA should also involve some problem-solving skills and the ability to use some aspect of the project to write a short program using a programming language determined by the teacher. The SBA is expected to be designed within the school and administered by the IT teacher.

Term 2 of the fifth year is spent mainly working on the SBA, but the SBA can be started earlier if schedules allow. Interim deadlines should be set for each of the four components. Data from one or more components can be used to complete others. The order in which the SBA is completed is determined by the project itself and may vary each year. The SBA is marked by the teacher using guidelines provided in the syllabus.

Your teacher should provide you with the description of the project. It will be based on one of the application areas suggested under Types of Projects in the syllabus. The project should comprise five tasks to be performed in the recommended application. Read through the description several times so you can become familiar with *what* you are expected to do, *how* you are expected to complete the various tasks using the applications, and *when* you are expected to provide results to your teacher. Your teacher may also provide the marking criteria so that you can see exactly how the marks will be awarded for each task. It is important that you read through your mark scheme as well. It would also be a good idea to read the instructions and keep an electronic copy of the SBA stored on your memory stick.

Group or individual SBA

If you are working on your own, then make a plan for how you intend to complete the tasks. You will be responsible for working through the entire SBA on your own.

If you have been assigned to a group, then arrange to meet and determine who will be group leader, as well as to make sure that everyone has the project description. It would also be useful to set up an online forum so that members of the group can collaborate to share ideas and progress on the SBA. It is also a good idea to work through the SBA individually so that all group members are familiar with the project. That way each member can make suggestions and learn from each other about suitable methods to approach or complete a task and to troubleshoot problem areas.

Preparing your data

Use the description of the project to decide where to start. Gather the data needed, such as names, addresses, dates of birth, items and so on. Start to work out the most suitable layout for the data. Then type in data in the application indicated in the project or using the most suitable application based on the description.

Create a folder for your SBA files. You may want to create multiple folders for each component so that your work is organised.

Make sure to name *every* document with a short description that includes your name or your group members' last names. Remember that your teacher will have many SBAs to review, and so having each document named appropriately will help you to get feedback quickly. You may want to start the name or label of each document with D1 for Draft 1 of your submission, then D2 for the second draft so that both you and your teacher know which submission is the most recent one.

Keep backup copies of your work at all times or email it to yourself. Keeping backups will mean that you do not have to start your project again from the beginning if anything happens to your files!

Working with your teacher

It is best to meet the interim deadlines set by your teacher in order for the SBA to be completed on time. Failure to complete and submit the SBA means that you forfeit 25% of your final mark and possibly fail the subject. If a section (database, spreadsheet, word processing, web page design, problem solving or programming) is incomplete, you should still submit your SBA for marking as the incomplete sections may still be worth marks.

Your teacher cannot help you if you do not have a file, a sketch of a layout or something to indicate your progress. Once you have entered data in a suitable format – continue to keep your teacher informed of your progress. Let your teacher provide feedback about the layout of your data and the accuracy of any calculations, tables, queries and so on. Make the effort to show where you or the group may need assistance or what stage you have reached.

Try to meet draft submission deadlines – have your submission ready for sending or delivering to your teacher. The intention is to provide you with a preliminary mark for your submission. This may be provided along with the details of the marks awarded. This feedback is an important part of the process and should be used to try to adjust your preliminary work before resubmitting for review. Ask your teacher about any tasks that you may need assistance with or any marks that have not been awarded based on the mark scheme.

Word processing

Your word-processing task and web page design should be developed with the overall theme of the project in mind. Try to incorporate the requirements based on the marking criteria.

Have a friend or a group member review all documents to make suggestions. If it is part of your SBA, you may want to perform the mail merge a few times or regenerate the table of contents to correct errors and tweak any formatting. Ask other people to give their critique of the documents – your English teachers, for example, and if possible, people in the workplace. The submission of this document should include your primary, secondary and final documents created by merging.

Web page design

Your web page can be created using a word processor or a free online web page software. Remember that it is limited to *one* web page. If a word processor is being used, then it is recommended that the design of the web page is created at the end of the word-processed document or in a separate document.

If an online web page builder is used, then paste the hyperlink to the online web page on the last page of your word-processed document. However, include screenshots in case the web page has not been published so that the moderator can still review the design.

It is important that you place your candidate number near the top of the web page as a form of identification.

Spreadsheet

Usually, the data used in your spreadsheet will be needed to complete tasks in the other applications. If this is the case for your SBA assignment, then an early start to planning your spreadsheet model is necessary. Consider the following:

- What is the best way to organise the data using one or more spreadsheets?
- What suitable row and column titles are needed?
- How many data items are required in each sheet?
- What functions and formulae should be used for the calculations?
- Which values can be referenced by using absolute addresses in functions and formulae?

- For any advanced filter or pivot table tasks, what criteria should be used, and where should the resulting data be placed?
- How should textual data be formatted (for example, features such as bold, italic, use of borders and merging cells)?
- How should numerical data be formatted (for example, accounting or currency and number of decimal places)?
- What type of chart(s) should be used, what data is necessary to create them, and where should they be placed (on the same sheet as the data or as a separate sheet)?

Database management

If the assignment of your SBA requires that you first create a database, then this data will be used in the other sections of the assignment. Alternatively, you may be required to import data from the spreadsheet part of the SBA to the database. However, you will need to demonstrate your ability to construct tables using appropriate field names, suitable data types and field sizes, or to modify the design of the imported tables.

Primary keys are necessary and should be assigned to appropriate fields in all tables. Every table created for your database should then form a part of a relationship, ultimately for the creation of form, queries and reports.

The design of data entry forms and sub-forms should emphasise good design features and clarity for the benefit of anyone who will make use of it (your teacher or the SBA marker). Consider the form colour, layout of fields, the font type and size of the labels and data being displayed.

Every query required for the database should produce a result, and every query should be saved using an appropriate name.

Like queries, reports should display a result. Attention to the layout of the information in a report is important since some field headings or narrowed columns may not be displayed properly. Adjustments to the placement of headings and orientation of the report should be clearly seen. That includes all titles, subtitles, fields and calculations required for the report.

Problem solving and program design

A collaborative approach has its advantages in this component of the SBA. However, if you are working alone, it certainly helps to seek the advice of others whilst managing this component. Try to approach the solution through discussions with your teacher to ensure that you and/or your group understands the scope and requirements of the problem. Create your algorithm. It may not be perfect but at least have one for your teacher to review. Your teacher can guide you towards a more accurate solution based on what you and/or your group would have submitted.

Implement your solution with the language selected by your teacher – test your solution thoroughly and record your test data and output in the form of screenshots. Fix any errors arising from your tests until the working solution and suitable output is reached.

Final submissions

Note that all of your work must be submitted to your teacher in soft copy. You may need to save some files in PDF format, or place them in folders according to the requirements for submitting your SBA.

Create an IT SBA folder with your name or the name of the group leader. Inside this folder create four subfolders – Word processing, Spreadsheet, Database, Problem solving and program design. Save the files into the folders.

- *Word processing:* If you have mail merge as a requirement, then you should have the primary and secondary document (even if it is a spreadsheet or database file), web page and final merged letters in this folder.
- *Spreadsheet:* All spreadsheet files in the Spreadsheet folder. If it is the same file that was used for the mail merge, then copy the file in this folder as well.

- *Database:* should contain your database file. Again, if it is the same file that was used for the mail merge, then copy the file in this folder as well.
- *Problem solving and program design:* You could have a number of different files in this folder, as shown in the list below. However, most of the information can be included in one word-processed document. The program with the code can be submitted as a separate file.

Cover sheet	The information supplied here is essential since it is used to identify your submissions
Problem definition	This can be a Word document that provides the statement of that part of the problem that was chosen for coding
Algorithm	You are expected to include flowcharts or pseudocode for the segment of code that will be written
Source code	A copy of the code written in the programming language chosen by the teacher
Trace table using test data	Supply the test data that produced the output to determine whether the tasks have been performed correctly
Program execution	Submit screenshots of the working program showing data entry and results produced

Your teacher should inform you of the process for submitting your IT SBA. You may be required to email your SBA, in which case you can zip the folder before attaching it to your email message. Be guided by your teacher for the submission of your SBA.

Again, it is very important to meet your teacher's deadline(s) for submission. Time must be allocated for processing received SBAs before uploading the final marks to CXC.

Appendix 2

Teacher guidelines for the School-Based Assessment

Teachers are encouraged to use the following guidelines to make sure that all the requirements for the students' SBA are provided. Since the SBAs are uploaded to a portal for moderation, there is no need to print any documents for submission. It is advisable to create a specific email address where students can email their submissions for review. Then folders created on a memory stick or hard drive can be created with the name of each student. These folders will store their submissions for grading and safekeeping until the samples have been chosen for moderation. A spreadsheet can also be used to track their progress for each component during the completion of their SBA.

The folder for each student should contain the submissions from the requirements of the SBA. You may wish to type out each requirement, similar to the list, so that you do not omit anything. Every mark counts for your students! The following list provides an overview of the requirements for the SBA.

Requirements for the SBA

Word-processing task(s) with table of contents	• Documents which require formatting of text with subscript, superscript, tables, fonts and different line spacing, page layout • Any two of: inserting/importing files, columns and/or tables • Any two of: table of contents, mail merge and/or fillable forms

Web page design	• A logo depicting the concept of the project
	• Defined areas on the page for navigational links and content
	• At minimum, two hyperlinks of the following:
	    • link to a location within the web page
	    • link to an email address
	    • link to another web page (which may or may not exist)
	    • link to user-created files

Spreadsheet/s	• A maximum of two major tasks (e.g. create the spreadsheet; modify the spreadsheet) • No more than THREE requirements (e.g. sorting of data, use of functions and formulae on data) • Creation of no more than TWO types of charts
Databases	• THREE tables or files • TWO queries (using criteria from one table, and more than one table) • ONE calculation within queries • ONE form, showing a main and sub-form (e.g. to search for a record, or to move to the next or previous record) • ONE report, with grouping and sorting involving TWO or THREE tables
Algorithm development	• A statement that defines the problem (e.g. you may want to calculate the average salary of a company's employees) • IPO, flowchart and/or pseudocode of solution • Trace table
Program implementation	• Program listing showing your code compiled free of errors • If necessary, the test data that you used from the trace table to produce the output should be provided as a printout

SBA mark scheme

In devising your mark scheme, remember that there are certain tasks that you cannot verify, such as confirming that the candidate used Find and Replace instead of manually correcting words! Here is a sample list of skills that cannot be verified by moderator, and therefore should not be included in your mark scheme.

Avoid allocating marks in your candidate's SBA for:

- use of a spellchecker
- Find and Replace
- block operations such as cut, copy and paste
- adding or deleting records
- changing field definitions.

Also try not to award more than 6 marks for layout and document formatting features such as justification; bold, underline and italics; single and/or double spacing; superscript and/or subscript; font and font size; bullets and numbering.

Appendix 3

Guidelines for problem solving and program design

The general-proficiency SBA consists of an individual project worth 90 marks. Students should therefore follow the steps below in developing the problem solving and program design section of their project.

Teachers are advised to use the Assessment Criteria found in the CSEC syllabus as a guide for allocating marks for the project. The copy containing the student's mark alongside CSEC criteria should be uploaded with each student's project when submitting the sample projects to the online portal provided by the Caribbean Examination Council (CXC®).

Define the problem

Defining the problem requires six steps:

1. *Specify objectives and user:* Explain what you are trying to accomplish and state the type of person who will be using this program.
2. *Specify the desired output:* What kind of output are you expecting from this program? You can write meaningful variable names and a brief description of each one.
3. *Specify the desired input:* Since you know what the output is, you can specify what the input should be. Again, write meaningful variable names and a brief description of each one.
4. *Specify the desired processing:* What processing should the input go through in order for it to provide the necessary output?

Design the program

This second stage consists of two steps:

1 *Design details using IPO charts or flowcharts:* Then begin to write your algorithm using pseudocode. This will be used as a guide when you start writing your program.
2 *Do a structured walkthrough:* You should go through the design and see if anything has been omitted or needs to be corrected. You can also use a trace table to check the logic of your algorithm.

Code and document the program

This stage is where the actual writing of the program starts. It consists of three main steps:

1 *Select the appropriate programming language:* For your SBA you will be using the programming language chosen by your teacher.
2 *Follow the syntax:* You can start writing the program from the flowchart or algorithm. Most programming languages have a particular syntax which you must follow.
3 *Put comments in your code:* First, write in programming code the purpose of your program. This is when you write comments to explain what your code is doing. For example, a comment such as `{Prompt for a number}` can be typed on a line above the code that actually prompts the user for a number.

   Then, as you write your code, it is best to include comments before conditional statements and loops to explain the purpose of the code. However, comments can be included anywhere in the code to clarify the logic of some sections.

Test the program

In order to test a program there are three things you must do:

1 *Perform desk-checking:* Manually go through the program making sure its logic works.
2 *Debug the program:* Use a compiler or interpreter to detect any programming errors. Then locate and correct these errors.
3 *Test the program with real-world data:* After you make sure that the program is correct, you must test the program by providing it with input and seeing what the output is.

Make sure that you take screenshots of the output of your program to include with your submissions.

Answers to end of topic questions

Topic 1.1

1 input, output, processing and storage *or* accept data, manipulate/process data, produce results and storing data and results
2 the IPOS cycle
3 hardware
4 **a** central processing unit
b control unit
c arithmetic and logic unit.
5 An input device gets data into a computer while an output device gets processed information out of the computer.
6 an operating system
7 **a** software
b communication technology.

Topic 1.2

1 **a** input device
b touchpad or touchscreen
c biometrics
d scanner
e direct data entry (DDE) device
f optical mark recognition (OMR)
g turnaround document.
2 **a** manual data entry
b remote control.

Topic 1.3

1 display devices, printing devices and audio devices
2 **a** pixel
b printer
c impact or dot-matrix printer
d thermal printer
e 3D printer
f earbuds.

Topic 1.4

1 to complete processing instructions as quickly as possible
2 **a** random-access memory (RAM)
b read-only memory (ROM)
c hybrid memory.
3 bit

Topic 1.5

1 secondary storage
2 magnetic media (hard drive), optical disks, flash memory drives
3 as backup storage
4 flash memory cards
5 Advantages: multiple users can access on document at the same time to make updates; users can access their data from anywhere and at any time once they have Internet access. Concerns: risk of data being accessed, deleted, stolen or corrupted.

Topic 1.6

1 to control the hardware and how all other software works
2 computer operating systems: LINUX, UNIX, Windows, Mac OS; mobile operating systems: Apple iOS, Android
3 **a** booting
b virtual memory.

Topic 1.7

1 **a** batch
b online *or* real-time
c online.
2 **a** import *or* download
b file compression.
3 **a** JPEG or PNG
b MPEG
c MP3.

Topic 1.8

1 **a** custom-written software
b specialised software
c integrated software.
2 Google Docs, Sheets *or* Slides, Microsoft 365
3 **a** presentation software, PowerPoint *or* Google Slides
b custom-written software.

Topic 1.9

1 **a** hardware
b hardware
c both.
2 too many options and sub-menus
3 **a** windows, icons, menus and pointers
b graphical user interface.

Topic 1.10

1 **a** personal computer
b mainframes
c an embedded system *or* embedded device.

Topic 1.11

1 The battery could be dead after prolonged use.
2 The cartridge may not be the correct one for the printer, the cartridge may not be installed properly *or* the ink may be dry in the cartridge.

Topic 2.1

1 The data is applicable *or* appropriate for the user.
2 accurate, timely, complete, appropriate *or* cost-effective
3 information commodity *or* information as a commodity.

Topic 2.2

1 data validation: to prevent errors.
data verification: to detect when errors occur.
2 bad sectors on a hard disk *or* bad memory
3 **a** 10am (*or* any time between 8am and 4pm)
b 300 *or* any number greater than 250
c 3, 4 *or* 5 days
d 100233.

Topic 2.3

1 **a** hard copy
b soft copy.
2 turnaround document, multiple choice sheet, lottery sheet, handheld computer *or* microfilm.

Topic 2.4

1 A data file is a collection of records and a record is a collection of related data fields
or file ⟶ records ⟶ fields or
fields ⟶ records ⟶ file
2 to help businesses store and update *or* modify large amounts of files containing data
3 primary key
4 **a** serial
b sequential
c direct access
d index sequential.

Topic 2.5

1 if the balance on the due date is greater than 0
2 temperature, pressure, liquid flow rate, proximity *or* amount of light.

Topic 3.1

1 **a** upload
b download.
2 paging systems, mobile (or cellular) networks *or* personal communication services
3 printers and computers
4 **a** wide area network
b local area network
c wireless local area network
d metropolitan area network.
5 peer-to-peer network
6 star, bus and ring
7 hotspot
8 **a** simplex
b half-duplex
c full duplex.
9 **a** cable
b wireless.
10 intranet

Topic 3.2

1 electronic (email), uploading data, downloading data, internet relay chat, browsing the web, file transfer protocol *or* newsgroups.
2 **a** converts analogue and digital signals between the telephone and the Internet
b sends data from the modem to different devices connected to it
c expands the number of devices that can be connected to a router
d provides the computer with a dedicated connection to a network.
3 **a** broadband
b 2G, 3G *or* 4G-LTE
4 blog: posts of text or picture entries; vlog: posts of video entries
5 Hypertext Markup Language (HTML)
6 Voice over IP (VoIP)

Topic 4.1

1 external: natural disasters: floods and other natural phenomena (hurricanes, earthquakes, volcanoes), power surges and spikes *or* terrorist activities that target buildings or rooms with computer systems.
internal: employee error, no backup procedures, no protection of hardware and/or software, no anti-virus programs *or* ex-employee data not removed from systems

2 **a** data security
b computer security
c security threat.

3 **a** Deliberate
b Accidental
c Cyber threat
d Cyber security.

Topic 4.2

1 **a** Computer fraud is unauthorised access and modification to financial accounts; propaganda is the use of computer systems to distribute information.
b Phishing is the use of websites and email messages that trick users into entering personal information; identity theft is the use of computerised systems to steal credit card information and other personal details.

2 **a** unauthorised access, single
b industrial espionage, multiple
c electronic eavesdropping, multiple
d denial-of-service (DOS) attack, multiple.

Topic 4.3

1 **a** Files can become damaged, corrupted or even lost.
b Saves and updates files that are no longer needed on a regular basis.

2 **a** false
b false
c false
d true
e true.

3 **a** fireproof cabinets
b uninterruptible power supply (UPS)
c lock computers to the desks *or* limit access to authorised persons and maintain records and logs of computer usage
d surveillance.

Topic 4.4

1 automation of jobs, retraining for different skills *or* the creation of new jobs

2 **a** poor *or* incorrect posture when using furniture or equipment
b using computer screens for long periods, poor lighting, glare *or* being too close to (or too far from) the screen.

Topic 4.5

1 database, network and systems administrators

2 Computer support specialists provide assistance directly to computer users; social media specialists communicate with the public *or* computer support specialists focus on troubleshooting and resolving computer problems; social media specialists share content with others.

Topic 4.6

1 Barcode readers used at point-of-sale (POS) linked to computer terminals automatically update inventory; credit/debit cards can be swiped so that money is automatically transferred to the business's account.

2 checking bank balance, transferring funds, paying bills online *or* viewing/printing bank statements

3 training simulations and interactive games

Topic 5.1

1 **a** Open retrieves a saved document; New creates a blank document.
b Save gives your document a filename for the first time, or resaves an existing document; Save As allows you to create a duplicate document with another filename.

2 Highlight the text – usually by using the mouse to drag over the required text.

3 **a** 3
b 2
c 3
d 2
e 2

4 *CTRL + 1, CTRL + 2, CTRL + 5*

5 quickly apply the formatting from one set of text to another

6 Advantage: it saves time searching manually for the word to replace it. Disadvantage: you may replace parts of other words that contain the characters you want to replace elsewhere.

Topic 5.2

1 a mark which shows the end of formatting applied to part of the document

2 Pages 17 and 35 will use odd section breaks and page 22 will use an even section break.

3 Section breaks can be used if you have a page of your document in portrait orientation and the next page is to be in landscape orientation *or* if you have different margins set for multiple pages.

4 A footnote appears at the bottom of a page to give more information about text in the document.

5 Similarities: footers and footnotes are both found at the bottom of a page. Differences: a footer is the same text repeated while a footnote can be a reference and varies from page to page.

Topic 5.3

1 A table is useful for organising and aligning text.

2 A column is added to the left or right of the current column; a row is added above or below another row.

3 4 rows; 3 columns

Topic 5.4

1 **a** spellcheck
b Track Changes
c Comment
d Word Count.

2 A spellcheck will ensure that words are spelt correctly according to a given dictionary; a thesaurus will suggest alternative words.

3 create a copy of the document; save as read-only; mark as final; use a password; restrict editing; or apply a digital signature.

Topic 5.5

1 copy or cut, and paste *or* Combine Documents

2 to combine information into one document

Topic 5.6

1 Select headings using Heading 1 or 2, place the cursor where the table of contents is to be placed and generate contents list.

2 update the page numbers only *or* the entire list to include the new heading

Topic 5.7

1 personalises letters to be sent to many people; saves time by not having to retype letters

2 letters, labels *or* envelopes

3 Selective mail merge allows you to choose specific data to merge, saving unnecessary printing.

4 You do not have to retype the data and possibly introduce typing errors.

5 a blank document, printer or email message

6 In the data source, select the box next to the record, select the category (field or heading at the top) or select all records.

Topic 5.8

1 margins, paper size, paper source *or* layout

2 Print creates a hard copy of your document, while Print Preview shows on screen how the document would look if it were printed.

3 entire document, single page or selected pages

4 collated (prints the document in order) or grouped (prints all copies of page 1, then all of page 2 and so on)

Topic 5.9

1 Paper-based forms:
Advantages: don't need Internet access to complete, can be distributed in a face-to-face environment like a class. Disadvantages: users may write incorrect information, need to re-enter the data to analyse it.
Online forms:
Advantages: saves paper, can be distributed in soft copy, data can be downloaded and analysed, captures specific type of data for fields. Disadvantage: not everyone is online to access the form.

2 **a** Rich text: users can type multiple paragraphs. Plain text: users type limited amount of text.

- **b** Combo box: select from list of choices or type in information. Drop-down list: only select from list of choices.

3 iv, v, ii, vi, iii, i

Topic 6.1

1 web browser
2 HTML (Hypertext Markup Language)
3 Google Chrome, Microsoft Edge, Microsoft Internet Explorer, Mozilla Firefox, Opera *or* Apple Safari
4 type the URL (web address) or use a search engine
5 A website consists of one or more web pages.
6 dynamic website
7 **a** shopping *or* e-commerce
b mobile
c community building *or* social networking.
8 content, organisation, number of web pages *or* security features

Topic 6.2

1 name of the website, web page, blog name, logo *or* company name
2 **a** Homepage > Flowers > Garden > Seedlings
b Sensible suggested arrangement.
3 A bookmark is a hyperlink that jumps to a different part of the web page.
4 You are either directed to another web page or a location within the current web page, or to open a document.

Topic 6.3

1 email address and password
2 web page designs, options to change font types, sizes and text alignment; the ability to add your own graphics, pictures or video; option to edit the background colour or upload a background image; integrate Google Maps to navigate to the location of your business; add a contact form or subscription page, etc.
3 to make sure that it is working well, e.g. that all graphics displaying correctly, text is in the correct position and background colours are not too bright
4 check each hyperlink; check that animations, audio and video are playing correctly; check that email addresses are valid; make sure that all pages link to the homepage *or* check page titles are appropriate
5 orphan page

Topic 7.1

1 budgets, financial statements, invoices *or* payroll
2 **a** spreadsheet
b column/row
c column/row
d =A1+A2
e =A1-A2
f WHAT–IF, forecasting
g Microsoft Excel
3 **a** =B4+C4
b =B4*2
c =C4/3
d =C4-B4
4 **a** column
b cell
c row.

Topic 7.2

1 A spreadsheet is also a workbook that consists of multiple worksheets.
2 Functions: =SUM(B1:G4), =MAX(E4:E6), =MIN(C1:C10), =AVERAGE(B1:C9). Formulae: =(E6-E4)*1, =E3*5%, =H2/3
3 to save time having to select the cells repeatedly
4 **a** Merge and Center
b C5
c D, E *or* F
d 1 *or* 2
e **i** left
ii right
f C3:C6
g SUM
h **i** MIN
ii MAX
iii The data in the column is too narrow for the width of the cell
j **i** yes
ii yes
iii yes
iv yes
v yes

Topic 7.3

1 the name box is in the top left-hand corner that shows the active cell I8
2 =D4*E4 *or* =E4*D4
3 =F4*10%
4 F6*CHARITY
5 right-click on cell E2, select Insert and click Entire column *or* Select column E and select Insert
6 **a** =MIN(D3:D6)
b =AVG(E3:E6)
c =COUNTA(A3:A6) – use COUNTA for the same range in columns A, B or C *or* =COUNT(D3:D6) – use Count for the same range in columns D to G.
7 =IF(G3<30,"CANCEL","")
8 cells I3 and I6
9 =IF(G4<E4,A4,G4)
10 25, 81, 61, Latin
11 **a** E5
b D6
c D5
d D5

Topic 7.4

1 **a** Currency, percentage, comma, increase/decrease decimal places
b wrap text, merge and centre cells, orientation, increase/decrease indent; horizontal/vertical alignment in the cell
c font style, size, bold, italics, underline, super/subscript; colour cell; colour text; border pattern

Topic 7.5

1 **a** sorting
b AutoFilter
c Advanced Filter
d pivot table.
2 **a** **i**

Day	Amount	Location
Wednesday	$10.00	Bench
Thursday	$13.00	Café
Friday	$14.00	Desk
Monday	$15.00	Lunchroom
Tuesday	$25.00	Desk

ii

Day	Amount	Location
Friday	$14.00	Desk
Monday	$15.00	Lunchroom
Thursday	$13.00	Café
Tuesday	$25.00	Desk
Wednesday	$10.00	Bench

iii

Day	Amount	Location
Wednesday	$10.00	Bench
Thursday	$13.00	Café
Tuesday	$25.00	Desk
Friday	$14.00	Desk
Monday	$15.00	Lunchroom

b **i**

Day	Amount	Location
Wednesday	$10.00	Bench
Thursday	$13.00	Café
Friday	$14.00	Desk

ii

Day	Amount	Location
Wednesday	$10.00	Bench
Thursday	$13.00	Café
Tuesday	$25.00	Desk
Friday	$14.00	Desk

Topic 7.6

1 A chart can make a greater visual impact than numbers.
2 An embedded chart is located on the same page as the data. A chart sheet contains a chart that is attached to your data but exists on a separate worksheet.
3 Chart title: a heading which is shown at the top of the chart. Category axis: identifies the data being charted on the horizontal x-axis; examples include dates and salespersons. Value axis: identifies the data being charted on the vertical y-axis; examples include numbers and years. Data series: the range of data selected to plot the chart.
4 A column (or bar) chart is useful for comparing two or more similar items. A pie chart shows the percentage of the wedges in the chart.
5 A legend is not necessary since there is only one set of data being plotted.

Topic 7.7

1 Advantage: You should print your data or charts so that you can view them away from the computer or distribute them to others *or* so that you have a hard copy in case you lose the data or the soft copy. Disadvantages: printing uses paper, which costs money and contributes to environmental damage *or* if you are not going to use the data afterwards then there may be no need to print it.

Topic 7.8

1 **a** MAX
b PRICES
c A4:A12
d The exclamation mark is used to separate the name of the worksheet from the cell.

Topic 8.1

1 telephone book, dictionary *or* recipe book.
2 an electronic library, travel agency *or* online store
3 **a** a database
b a spreadsheet
c a word processor.

Topic 8.2

1 database, table, record, field
2 last and first could refer to names but it would be more appropriate to use LastName, FirstName or lastname, firstname. ID can refer to 'identification'; but it is better to use more meaningful names such as ProductID for PR-ID and CustomerID for CID.
3 primary key: **a**, **b**, **c** and **e**; candidate key: **f** and **g**; composite key: **h**; foreign key: **d**
4 Numeric data types are mainly used in fields where calculations are performed. Unless a primary key is created based on a calculation then it should be a text field.
5 **a** text
b text
c text
d number
e Y/N (Boolean)
f text
g date
h text
i text or AutoNumber
j number.
6 **a, b** LastName and FirstName: text, 15; Relation: text, 15; Month of birth: number, 2 (using the numbers of the months as 1 to 12); Male?: Y/N, size of 1 character (Boolean); Adult: Y/N or Boolean (Y says you are an adult)
c Since you may have more than one person in the family with the same first name, it may be best to let the database create a primary key.

Topic 8.3

1 **a** Customer and Order (1:M); Product and Order (1:M)
b Customer: CID; Product: PR_ID; Order: CID+PR-ID
c Lou and Ann
d Pocket Diary
e 4
2 **a** Athlete and Division
b 4
c 2
d Athlete table: AthleteID, Division table: Code
e Athlete table: Code
f Code
g 1:M; one division has many athletes.
h It cannot be deleted since there are athletes linked to this category. The athletes must be removed/deleted first.
i Yes, this athlete can be deleted from the table.
j Figman McJig
k Under 13

Topic 8.4

1 Datasheet view allows you to enter raw data into each field of your database table. Design view allows you to enter field names, data types and descriptions into your database table.
2 form
3 check box and value list

Topic 8.5

1 ascending *or* ordering top to bottom
2 **a** Product
b Description and Cost
c Cost < 3
d Cost <= 3
3 **a** Product and Order
b Description and Discount
c Discount = 'Y'

Topic 8.6

1 **a** [Firstname] & " " & [Lastname]
b [Lastname]& " , " &[Firstname]
c [description] & " cost $ " & [cost]
2 incorrectly spelling a field name
3 **a** Total cost: [QTY]*[Cost]
b Deduction:[Cost]*.10
c NewCost:[Cost]*1.10
4 **a** SUM
b MIN
c MAX
d COUNT.

Topic 8.7

1 Tabular; since it is formatted like a table with rows and columns.
a First, Last and Description are text; Cost, Quantity and TOTAL COST are numbers (Cost and TOTAL COST can also be currency); Discount is Yes/No *or* Boolean.
b First and Last are the grouping fields.
c First (sorted automatically with the grouping); Cost in descending order
d TOTAL COST
e Order Report – February
f 3
3 **a** Department, LastName, FirstName and DaysWorked are text fields; Fees is a numeric *or* currency field.
b Department
c LastName
d Fees
e Payroll for September
f SUM

Topic 8.8

1 Exporting is saving a copy of data from the current application which can be opened in another application. Importing creates a copy of data from another application in an existing database.
2 Use the copy and paste method.

Topic 8.9

1 To make sure you have included all the information that is required.
2 Have adequate field lengths; break down names and addresses to appropriate fields; think how tables can be linked; give the tables meaningful names.
3 To make sure the design stores and retrieves data correctly.
4 Tables that contain unrelated data; blank fields that should contain data; tables that contain the many duplicate fields of data.

Topic 9.1

1 algorithm phase and implementation phase
2 I = input, P = processing, O = output
3 IPO charts identify the data needed to convert the input into the desired outputs.
4 **iii, v, i, ii, iv**

Topic 9.2

1 **a** true
b false
c false
d true
e true
2 A variable stores data for the program to work with.
3 The values in a variable can change while the values do not change for a constant.
4 **a** integer
b real
c string or text
d Boolean
e string or text.
5 **a** year
b height
c mobile_num
d day (or night)
e blood_type

Topic 9.3

1 **a** REPEAT (count = count - 2) UNTIL count = 25
b FOR (count = 1 to 20) DO
count = count * 5
c IF total = count * 5
THEN display count

2 **a** Loop A: REPEAT
b Loop B: WHILE.

3 Left:

a **i** Num
ii Blu and Met
iii BEGIN, INPUT, DISPLAY, END
iv + and –
v no Boolean operator

b **i** no
ii no
iii yes
iv yes.

Right:

i word
ii no constant
iii BEGIN WHILE, IF, THEN, ELSE, DISPLAY, ENDWHILE
iv no arithmetic operator
v <>

b **i** yes
ii yes
iii no
iv yes.

4 **a** input hours, total = hours * 10, Output total
b input cost, amount, cash = amount – cost, output cash

5 **a**

```
INPUT mark1, mark2, mark3,
mark4
total = mark1 + mark2 +
mark3 + mark 4
OUTPUT total;
```

b

```
mark = 0
total = 0
WHILE (number <= 4) DO
BEGIN
      INPUT mark
      Total = Total + mark
ENDWHILE
OUTPUT Total
END
```

c

```
mark = 0
Total = 0
REPEAT
      INPUT mark
      Total = Total + mark
UNTIL (number = 4)
OUTPUT Total
END
```

d

```
FOR Count = 1 to 4 DO
      INPUT mark
      Total = Total + mark
      ENDFOR
OUTPUT Total
```

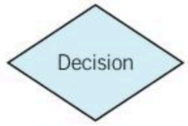
Topic 9.4

1 **a**

b

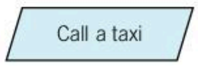
c → flow line

d



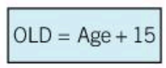
e

2 **a**

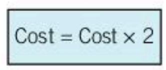


b

c

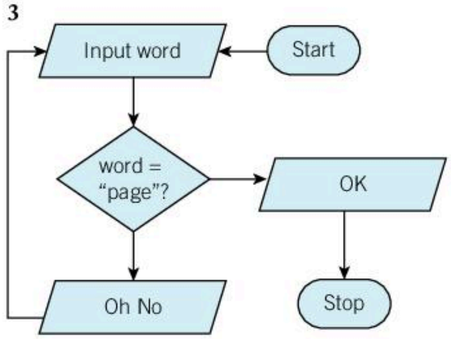


d



e

3



Topic 9.5

1 **a** =
b –
c +
d >=

2 **a** sisters = 3
b age <= 18
c passes =7
d weeks <= 4
e pension >= 65
f cheque <> cash

3 **a** false
b false
c false
d false
e true

4 **a** +
b =, <, <=
c AND

5 **a** **i** (word <> password), (count <= 3)
ii 'Access' and 'Forgot password'
iii 4

b

word = password	**count <= 3**	**(word <> password) AND (count <= 3)**
TRUE	TRUE	Access
TRUE	FALSE	Forgot password
FALSE	TRUE	Forgot password
FALSE	FALSE	Forgot password

6 $2^{\text{number of conditions}} = 2^3 = 2 \times 2 \times 2 = 8$ conditions

7 See below

Topic 9.6

1

Mark	**Total**	**Count**	**Average**
25	25	1	25.00
30	55	2	27.50
12	67	3	22.33
10	77	4	19.25
–1			

2 mark = 65 await end of term report;

mark = 71 Satisfactory results!; await end of term report;

mark = 82 Excellent results!; see your teacher; await end of term report

3

Sum	**Count**
0	2
2	3
2	4
6	5
6	6

Topic 10.1

1 Low-level languages are machine-dependent and not easy to understand by humans. High-level languages must be converted to machine language and are easier to understand by humans.

Topic 10.2

1 Syntax is a set of rules when writing a programming language. Semantics is the meaning associated with the words, symbols and punctuation that make up the language.

2 Variable declaration means giving a new name and a data type for the variable.

3 so that they are easy to remember and understand

7 (Topic 9.5) T = TRUE, F = FALSE

A	B	NOT A	NOT B	A AND B	A OR B	(NOT A) OR B	NOT (A OR B)	NOT (A AND B)	A AND (NOT B)
T	T	F	F	T	T	T (garden)	F (town)	F (town)	F (town)
T	F	F	T	F	T	F (town)	F (town)	T (garden)	T (garden)
F	T	T	F	F	T	T (garden)	F (town)	T (garden)	F (town)
F	F	T	T	F	F	T (garden)	T (garden)	T (garden)	F (town)

Topic 10.3

1 program listing
2 A translator converts program code to machine code. Examples are compilers, interpreters and assemblers.
3 Debugging finds errors in program code and corrects them.

Topic 10.4

1 **a** Testing tries to find problems in your code. Debugging isolates and fixes the problems.
  b Black box testing is used to check that the correct output of a module is produced from the input. White box testing checks the accuracy of processing from input, through every possible path through to the output.
2 Input values, recording expected and actual output. Every conditional branch and loop must be tested at least once, and follow as many paths within each module and function as possible.
3 reliable, stable, easy to maintain, easy to use *or* portable
4 Examples of values: 4, 5; 2, 2; −2, 4; 0, 2.5.

Topic 10.5

1 to allow others to maintain the application if the original programmer is not available; to allow others to see internal and user details of the application
2 if the program needs to be debugged or updated, to understand what the code is doing or supposed to do
3 **a** curly brackets {}
  b single quote '
4 System documentation is written by technical persons for technical persons and is concerned with how the program works. User documentation is concerned with what the program does and how the end user makes the program do what it is supposed to do.
5 **a** overview of the process and tasks, name(s) of the authors of the program, date that program was created or modified or reviewed
  b overall system specification showing how the requirements are broken into a set of interacting programs; test plans describing how each program unit is tested; acceptance test plan describing the tests which must be satisfied before the system is accepted
  c functional description explaining what the system can and cannot do; installation document explaining how to install the application and gicing suggestions how to recover from errors and basic problems when things go wrong; introductory manual explaining in simple terms how to get started with the system; reference manual describing system facilities available to the user and how these facilities can be used.

Topic 11.1

1 **a** invalid
  b invalid
  c invalid
  d valid
  e valid
2 identify and correct each error individually; save the program; compile the program again

Topic 11.2

1 **a** A compound statement: comprises two or more statements within Begin and End keywords. A simple statement comprises a single instruction.
  b write places the cursor immediately after the text that is written on the screen. writeln prints the text on the screen then places the cursor at the beginning of the next line.
  c := is used in an assignment statement. = is an operator to check equality.
2 **a**

Output with line = 85	
Fragment 1	Fragment 2
Extra line	Extra line
Same line 5	

  b

Output with line = 55	
Fragment 1	Fragment 2
Same line 30	Same line 85

  c and d are practical work to observe the same answers output as in parts **a** and **b**
  e Fragment 2

Topic 11.3

1

```
{Name, date and purpose of
program}
Program Calculate_age;
Var thisyear, birthyear, age :
integer;
Begin
   {Prompt to enter two dates}
   Write ('Enter this year:');
   Readln( thisyear );
   Write('Enter a birthyear:');
   Readln(birthyear);
   {Calculate the age}
   age := thisyear -
   birthyear;
   If age < 13
   Then Writeln('A teen')
   Else Writeln ('Not a
   teen');
End.
```

2

```
{Name, date and purpose of
program}
Program Q2;
Var number, count: integer;
Begin
   {initialise the variable
   number}
   number := 1;
   While (number <= 3) Do
   Begin
      {Increment number by 1}
      count := count + 1;
   {Output the number}
   Writeln('You have entered',
   number);
   End;
   Writeln('out of loop');
End.
```

3

```
{Name, date and purpose of
program}
Program Q3;
Var age: integer;
Begin
   For age := 13 to 19 Do
   Writeln('You are a
   teenager');
End.
```

4

```
{Name, date and purpose of
program}
Program Q4;
Var total, count, mark:
integer;
average : real;
Begin
   {Initialise variables}
   total := 0;
   count := 0;
   mark := 0;
   {Prompt to enter a mark}
   Write('enter mark');
   Readln(mark);
While (mark <> -1) Do
Begin
{Add the mark and increment
the count}
   total := total + mark;
   count := count + 1;
   Writeln('enter mark');
   Read(mark);
End;
{If count = 0 then no marks
were entered}
   If count = 0
   Then writeln('no marks
   entered')
{Else calculate the average}
   Else begin
   average:= total/count;
   Writeln('The average is',
   average);
   End;
End.
```

Topic 12.1

1 add the Developer tab
2 submit, OK, Cancel *or* Close
3 activeX Controls group
4 make sure Design Mode is deselected by clicking it by remove the highlighting.
5 as a macro-enabled workbook

Topic 12.2

1
```
Private Sub CommandButton1_
Click()
Dim message As String
   'Type a message in cell J5
   MsgBox Range("J5").Value
   'Click command button to
   output message
End Sub
```

2
```
Private Sub CommandButton1_
Click()
Dim info As Integer, message
As String
   info = Range("D5").Value
   'Type number in cell D5
   If  info = 10 Then
   message = "Correct number!"
Else:
   message = "Sorry!"
End If
   Range("J15").Value =
   message
   'Click command button to
   output message
End Sub
```

3
```
If eligible > 4 Then
result = "Well done!"

If eligible < 3 Then
result = "Good work"

Private Sub CommandButton1_
Click()
Dim total As Integer, message
As String
   total = Range("J8").
   Value + Range("J10").
   Value + Range("J12").Value
   ' add numbers in cells J8,
   J10, J12
If total > 6 Then
   message = "Prize and
   Plaque"
Else:
   message = "Sorry!"
End If
   Range("J15").Value =
   message
   'Put answer in cell J15
End Sub
```

4
```
Private Sub CommandButton1_
Click()
Dim age As Integer, message As
String
   age = Range("G10").Value
   'Place age in cell G10
   Select Case age
   Case Is >= 18
   message = "Tertiary"
   Case Is >= 16
   message = "Secondary"
   Case Is >= 11
   message = "Primary"
Case Else
   message = "Nursery"
End Select
   Range("G12").Value =
   message
   ' Output message in G12
End Sub
```

5
```
'Type names of drinks in Cells
A2 to A6
'Type cost of drings in cells
B2 to B6
Private Sub CommandButton1_
Click()
Dim cost As Integer
   cost = 2
   Do While Cells(cost, 2) <>
   ""
   Cells(cost, 3).Value =
   Cells(cost,2).Value * 1.15
   cost = cost + 1
Loop
End Sub
```

6 a
```
Private Sub CommandButton1_
Click()
Dim thisyear, birthyear, age
As Integer
   MsgBox "Enter two dates,
   this year and a birth day"
   thisyear = InputBox("Enter
   this year", "Information
   Required", 2018)
   birthyear = InputBox("Enter
   your birth year",
   "Information Required", 0)
   'Calculate the age
   age = thisyear - birthyear
   If age < 13 Then
   MsgBox "A teen!"
Else
   MsgBox "Not a teen"
End If
End Sub
```

b
```
'Name, date and purpose of
program
Private Sub CommandButton1_
Click()
Dim number, count As Integer
number = 1
Do While number <= 3
   number = InputBox("Enter
   an integer", "Information
   Required", 0)
   'Increment number by 1
   count = count + 1
   'Output the count
   MsgBox "You have entered "
   & number
Loop
MsgBox "out of loop"
End Sub
```

c
```
Private Sub CommandButton1_
Click()
Dim age As Integer
   For age = 13 To 19
   MsgBox "You are a teenager"
   Next age
End Sub
```

d
```
Private Sub CommandButton3_
Click()
Dim Total As Integer, Count As
Integer, Average As Double,
mark As Integer, Message As
String
Total = 0
Count = 0
Average = 0
mark = 0
Do While mark <> -1
mark = InputBox("Enter mark",
"Information Required", 0)
If mark = -1 Then
Message = "End of marks"
Else
Total = Total + mark
   Count = Count + 1
   End If
Loop
If Count = 0 Then
Message = " No marks entered"
Else
Average = Total / Count
Range("C4").Value = Average
MsgBox Average
End If
End Sub
```

7 **a** amount, interest, years, payment
b C2, C3, C4, C5
c PMT
d Cell C2 contains 50,000, C3 contains 8.5%, C4 contains 7, C4 contains =PMT(C3/12,C4*12,-C2).

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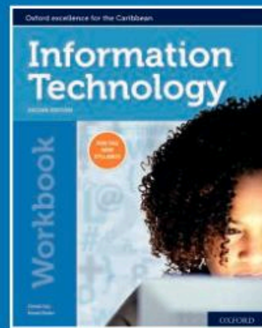

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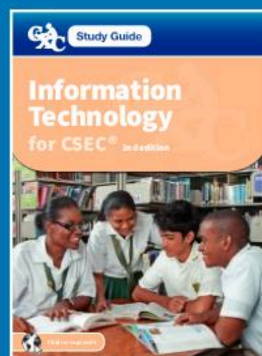

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ISBN 978-0-19-843716-1